WORK PLAN

FOR

- WATERSHED PORTECTION
- FLOOD PREVENTION
- WATER RESOURCE IMPROVEMENT FOR RECREATION

FLAT ROCK CREEK WATERSHED

CRAWFORD COUNTY, ARKANSAS

MAY 1970

4-30703 9-71
USDA-SCS-FORT WORTH, TEX. 1971

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WATERSHED WORK PLAN AGREEMENT

between the

Clear Creek Soil and Water Conservation District
Local Organization

City of Van Buren, Arkansas
Local Organization

_____
Local Organization

_____
Local Organization

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Local Organization

_____
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Arkansas

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Flat Rock Creek Watershed, State of Arkansas, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for the works of improvement for the Flat Rock Creek Watershed,

State of Arkansas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated Cost $ 443,550).

2. The Sponsoring Local Organization will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Sponsoring Local Organization will comply with the real property acquisition policies contained in said Act and Regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

   The Service will bear 100 percent of the first $25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of $25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	18.54	81.46	3,000

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Multiple Purpose Structure Number 1	18.17	81.83	220,250
Floodwater Retarding Structure Number 2	0	100.00	340,000
Channel Numbers 1 and 2	0	100.00	1,907,901

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
Multiple Purpose Structure Number 1	0	100.00	19,152
Floodwater Retarding Structure Number 2	0	100.00	30,357
Channel Numbers 1 and 2	0	100.00	170,348

6. The Sponsoring Local Organization and the Service will each bear their costs for project administration estimated at $ 11,399 and $ 461,701, respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance

of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving the funds of the other party. Such arrangement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.S. Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any activity receiving Federal financial assistance.

Clear Creek Soil and Water
Conservation District
Local Organization

By Paul Alexander

Title Chairman

Address Mulberry, Arkansas 72947
Zip Code

Date September 8, 1971

The signing of this agreement was authorized by a resolution of the governing body of the Clear Creek Soil and Water Conservation District
Local Organization
adopted at a meeting held on September 8, 1971.

Lora Dean
(Secretary, Local Organization)

Address Alma, Arkansas 72921
Zip Code

Date September 8, 1971

City of Van Buren, Arkansas
Local Organization

By Allen R. Toothaker

Title Mayor

Address Van Buren, Arkansas 72956
Zip Code

Date September 8, 1971

The signing of this agreement was authorized by a resolution of the governing body of the City of Van Buren, Arkansas
Local Organization
adopted at a meeting held on September 6, 1971.

E. L. Hobbs
(City Clerk, Local Organization)

Address Van Buren, Arkansas 72956
Zip Code

Date September 8, 1971

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION AND WATER RESOURCE IMPROVEMENT FOR RECREATION

FLAT ROCK CREEK WATERSHED

Crawford County, Arkansas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666), as amended

Prepared By:

Clear Creek Soil and Water Conservation District
(Cosponsor)

City of Van Buren, Arkansas
(Cosponsor)

With Assistance By:

United States Department of Agriculture
Soil Conservation Service
Forest Service

May 1970

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WATERSHED WORK PLAN

FLAT ROCK CREEK WATERSHED

Crawford County, Arkansas

May 1970

SUMMARY OF THE PLAN

General Summary

This work plan for watershed protection, flood prevention, and water resource improvement for recreation for the Flat Rock Creek Watershed was prepared by the Clear Creek Soil and Water Conservation District and the City of Van Buren, Arkansas, as cosponsoring local organizations. Technical assistance was furnished by the United States Department of Agriculture, Soil Conservation Service and Forest Service.

The 18,952-acre watershed is located in west-central Arkansas in Crawford County. The county seat of Crawford County, Van Buren, and the community of Shibley are located in the watershed.

Flat Rock Creek and its tributaries are the main drainageways of the watershed. The watershed is bound on the north by Clear Creek, on the east by Mays Branch, on the south and southwest by the Arkansas River, and on the northwest by Lee Creek.

The topography of the watershed varies from the relatively flat Arkansas Valley flood plain in the southern portion of the watershed to mountainous slopes and steep stream valleys in the northern portion of the watershed. Elevations range from about 378 feet above mean sea level in the bottomland to about 1,100 feet along the watershed boundary.

The entire watershed is in the Arkansas Valley and Ridges Land Resource Area. The watershed is underlain by Paleozoic age shale and sandstone and unconsolidated alluvial materials of Quaternary and Recent ages.

The present watershed population is estimated to be about 8,000 of which 2,100 are rural and 5,900 are urban. There are presently about 150 farms in the watershed with an average size of 110 acres. The watershed flood plain is a 1,030-acre area subject to flood damage, as delineated by the 100-year frequency flood. Flood prevention benefits will accrue to the owners and operators of 30 farms and 167 urban properties in the flood plain. During the 100-year evaluation period, all floods produced average annual flood damages of $141,070.

Installation of this project will help to meet the objectives of the Western Arkansas Economic Development District, the Ozarks Economic Development Region, and the Arkansas River Valley Resource Conservation and Development Project by developing, conserving, improving, and

utilizing the natural resources of the area to enhance the economic and social welfare of the area's residents.

This work plan proposes the installation of land treatment and structural works of improvement to be accomplished during a 5-year installation period. The total estimated cost of the project is $3,856,818 of which $3,142,400 will be borne by Public Law 566 funds and $714,418 will be borne by other funds.

Landowners and operators with assistance from federal and state agencies will install and maintain land treatment measures which will have a measurable effect on the reduction of flood damages. The cost of these measures is estimated to be $249,160. This includes $29,700 of Public Law 566 funds and $219,460 of other funds. Local interests in recent years have expended about $163,695 installing land treatment measures.

Structural measures consist of one multiple purpose structure (flood prevention and water resource improvement for recreation), one floodwater retarding structure, and 7.4 miles of channel improvement. The total estimated cost of these structural measures is $3,607,658. The share from Public Law 566 funds is $3,112,700 and the share from other sources is $494,958.

The average annual benefits accruing to structural measures are distributed as follows:

Flood Prevention	
Damage Reduction	$134,210
Intensified Land Use	3,900
Changed Land Use	
Agricultural	4,560
Urban	40,700
Recreation	10,350
Redevelopment	20,550
Secondary	59,400
Total	$273,670

The average annual cost of structural measures is estimated to be $187,343. The ratio of average annual benefits to average annual costs of structural measures is 1.5 to 1.

The Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, which has the powers of taxation and eminent domain has filed a letter of intent to secure a watershed loan administered by the Farmers Home Administration. Funds obtained from this loan will be used to finance their share of installing the structural measures.

The City of Van Buren, Arkansas, will assume the local responsibility for construction and land rights for Multiple Purpose Structure Number 1.

Floodwater Retarding Structure Number 2 and the channel improvement will be operated and maintained at an estimated annual cost of $1,100

(adjusted normalized prices) by the Clear Creek Soil and Water Conservation District through the Flat Rock Creek Improvement Project Area. Multiple Purpose Structure Number 1 will be operated and maintained by the City of Van Buren, Arkansas, at an estimated annual cost of $300 (adjusted normalized prices).

DESCRIPTION OF THE WATERSHED

Physical Data

Flat Rock Creek Watershed is located in west-central Arkansas in Crawford County. The watershed comprises 18,952 acres, approximately 75 percent of which is upland area. The county seat of Crawford County, Van Buren, is located within the watershed. The community of Shibley is located in the watershed.

Flat Rock Creek and its tributaries are the main drainageways of the watershed. The watershed is bound on the north by Clear Creek, on the east by Mays Branch, on the south and southwest by the Arkansas River, and on the northwest by Lee Creek.

The topography of the watershed varies from the relatively flat Arkansas Valley flood plain in the southern portion of the watershed to mountainous slopes and steep stream valleys in the northern portion of the watershed. Elevations range from about 378 feet above mean sea level in the bottomland to about 1,100 feet along the watershed boundary.

The entire watershed is in the Arkansas Valley and Ridges Land Resource Area. The watershed is underlain by Paleozoic age shale and sandstone and unconsolidated alluvial materials of Quaternary and Recent ages.

Natural resources in the Flat Rock Creek Watershed include deposits of sandstone, shale, gravel, sand, and natural gas. Large quantities of sandstone are found within the boundaries of the watershed and one large sandstone quarry is located in the north-central portion of the watershed. Mining of shale for roadstone is limited to small isolated areas in the watershed. Extensive sand and gravel deposits occur in the bed of the Arkansas River near the mouth of Flat Rock Creek Watershed, but mining of sand and gravel in the watershed will be limited to small, isolated deposits along Flat Rock Creek and its tributaries. Large quantities of natural gas reserves exist in the watershed. The nearest known producing gas wells to any planned structural measures are more than 2.5 miles from such structural measure and continued extraction from these wells is not expected to adversely affect the foundations of the structural measures. There are no known existing dry holes, mine openings, or other known pollution sources within the pool areas or drainage areas of Structure Numbers 1 and 2.

Water quality in the proposed reservoirs is expected to be good. The land use in the drainage area of the reservoirs is predominantly woodland, pasture, and range.

The soils in the uplands of Flat Rock Creek Watershed have developed from acid sandstone and shales. They are: (1) the deep, moderately permeable Linker and Allen soils; (2) the moderately deep, very slowly permeable Enders soils; (3) the moderately deep, slowly permeable Leadvale (Locust) and Cane soils; (4) the shallow, rapidly permeable, well-drained Mountainburg soils; and (5) the shallow, moderately permeable, well-drained Montevallo soils.

The terrace soils are: (1) the deep, well-drained, moderately permeable Pickwick and Sequatchie soils; (2) the deep, moderately well-drained, slowly permeable Leadvale (Monongahela) soils; and (3) the deep, somewhat poorly drained, slowly permeable Taft soils.

The soils of the bottomland area have developed principally from sediment carried by the Arkansas River. They are: (1) the deep, poorly drained, very slowly permeable Iberia and Wrightsville soils, (2) the deep, well-drained moderately permeable Yahola soils, and (3) the deep, excessively drained, rapidly permeable Bruno soils. The flood-plain soils are mostly the deep, well-drained, moderately permeable Cleora and the moderately well-drained, slowly permeable Philo soils.

Land Use	Present	Future
Cropland	4,714	4,011
Pasture and Hayland	2,600	3,340
Rangeland	4,038	3,641
Woodland 1/	4,270	3,910
Wildlife Land 1/	630	830
Recreation Land	-	60
Other Land	2,700	3,160
Total	18,952	18,952

1/ While all forest cover is recognized as wildlife habitat, the primary use of about 320 acres of present woodland and 410 acres of future woodland is dedicated by the landowners to wildlife management. These acreages are included as woodland.

Twenty-two percent or 4,270 acres of the watershed is in forest cover. Almost all of this occurs as small, scattered patches in the rolling hills of the upland portion of the watershed. Species composition in these upland forests is primarily low-grade oak-hickory-elm. Except for about 300 acres in wet lands contiguous to Hollis Lake, the flood plain is almost entirely in cultivation. The major tree species in the flood plain are willow, cottonwood, and ash.

Half of the wooded acreage dedicated to wildlife use is located in these wet swamp tracts in major bottoms. The remainder is in sparse upland forest cover generally found in small, isolated patches that are dispersed in patterns and sizes difficult to manage for timber production.

Over four-fifths of the wooded lands are in small farm holdings. The only industrially held forest land is a 300-acre upland tract managed

for sand and gravel and not timber. The City of Van Buren owns almost 70 acres of woods in two tracts, 60 acres in a municipal park and 6 acres on a reservoir site. Neither tract is under forest management. No State or National Forest lands are found in the watershed.

The hydrologic conditions of the forest soils and the silvicultural conditions of the forest stands are generally very poor. These deteriorated woodlands are the result of generations of neglect, indiscriminate burning and grazing, and destructive logging practices. While most of the damage occurred years ago, these poor woodland conditions are perpetuated and often worsened on well over half of the tracts by present neglect and abuse. Forty percent of the forested areas examined showed moderate to severe grazing damage. Only rarely have forestry practices been applied on forest lands with or without REAP assistance.

The inherent site capability is much greater than the existing woodland conditions indicate; therefore, accelerated management and improved protection efforts in the watershed will improve the woodland hydrologic conditions from very poor to fair.

Based on a 30-year record, the mean annual rainfall is 42.22 inches. The maximum recorded annual rainfall of 76.66 inches occurred in 1945. The minimum was 22.77 inches in 1901. The gage is located at Fort Smith, Arkansas.

The mean monthly rainfall in inches is:

January	2.66	July	2.80
February	3.43	August	2.92
March	3.47	September	3.64
April	4.24	October	3.45
May	5.26	November	3.18
June	4.35	December	2.82

Mean temperatures range from 38.8 degrees Fahrenheit in January to 83.0 degrees Fahrenheit in July. The minimum temperature of record is 15 degrees below zero and the maximum is 110 degrees. The normal frost-free period of 234 days extends from March 21 to November 10.

Land Treatment Data

The watershed is served by the Clear Creek Soil and Water Conservation District. Assistance is provided to the district by the Soil Conservation Service work unit at Van Buren, Arkansas.

There are about 60 landowners in the watershed presently cooperating with the soil and water conservation district. These cooperators own approximately 7,500 acres or about 44 percent of the watershed, excluding the urban area of Van Buren.

Basic conservation plans have been developed for about 55 of the cooperators and cover approximately 7,000 acres or 41 percent of the non-urban land in the watershed.

Crop production is of minor importance in the upland portion of the watershed. A permanent vegetative cover is maintained on the upland primarily in the form of grass and hay for livestock support. The woodland in the watershed is almost exclusively in the upland area. In some cases, the proper treatment of the land has been neglected due to off-farm employment or for some other reason.

Very intense crop production occurs on the majority of the flood plain and adjacent bottomland that is not devoted to urban or industrial uses. Cropping systems that involve a spring and fall crop of vegetables or which combine soybeans and wheat are common. The most abundant single crops are soybeans, alfalfa, watermelons and cantaloupes, and small grains. Other vegetable crops, including cabbage, cucumbers, peas, sweet corn, sweet potatoes, tomatoes, peppers, and squash occupy considerable acreage even though the acreage of each individual crop is small. These uses are compatible with the capability of the land. Land treatment measures have and are being applied but flooding prevents optimum efficiency from being achieved in the operations.

The measures which have been applied to date have proven effective in reducing runoff and soil erosion and have improved the condition and fertility of the soil. These measures represent an estimated expenditure of about $163,695 (table 1A), which is 42 percent of the cost of total land treatment needs in the watershed. Adequate treatment has been accomplished to date on approximately 44 percent of the cropland and 64 percent of the grassland.

No forest land treatment measures have been applied to the watershed during the past five years.

Adequate fire protection is available through the Arkansas Forestry Commission in cooperation with the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. Other available federal-state forestry programs include cooperative forest management, cooperative reforestation, general forestry assistance, and cooperative insect and disease control.

Standard soil surveys have not been completed for the watershed. The lack of complete standard surveys at the present time is not expected to hinder the installation of the needed land treatment measures. It is expected that $2,500 of Public Law 566 funds will be required in order to accelerate and complete the surveys during the installation period.

Economic Data

Agriculture does not dominate the watershed economy as it once did. The sharp increase in manufacturing and services in the local area in recent years has attracted most of the attention and caused a tendency to overlook the important role of farming in the economy. Even though the relative position of agriculture has declined, the loss of position results from increases in other sectors rather than an actual downward movement in agricultural sales. In fact, the value of agricultural products sold has risen steadily in the past decade.

In the past, a considerable amount of the upland area was devoted to crop production, namely cotton and corn. In many cases, this production was not suited to the shallow soils and steep slopes. The incomes and profits from farming declined and, as many of the small farms became marginal or submarginal, most of the upland operators abandoned crop production and sought other sources of income.

Many employment opportunities were available at Van Buren located in the watershed and Fort Smith located just outside the watershed. Outmigration was less severe in the watershed than it was in the surrounding area. The rural population of the watershed declined an estimated 15 percent between 1940 and 1960, whereas the rural population of Crawford County decreased over 40 percent during the same period.

The rural population loss in the watershed was more than offset by the gains in the urban population of Van Buren. As a result of the gain in urban population, the total watershed population increased from about 6,000 in 1940 to approximately 6,800 in 1960. The present watershed population is estimated to be about 8,000 of which 2,100 are rural and 5,900 are urban.

The loss in rural population was accompanied by a decline in the number and increase in size of farms. There are presently about 150 farms in the watershed with an average size of 110 acres. This is below the average size of 125 acres for Crawford County due to the number of small ownerships that are primarily rural, nonfarm residences.

The watershed residents are making a determined effort to efficiently utilize the natural resources. Particular attention is being paid to the prevention of erosion. In the upland, crop production is pursued on a few scattered fields. The predominant enterprise is livestock production which is largely dependent upon forage and most of the upland area supports a permanent vegetative cover of native and improved grasses.

Forest land which comprises about 22 percent of the watershed area is located almost exclusively in the upland. Even though several wood-using outlets for sawlogs and pulpwood lie within easy reach of the watershed, farm forests have had relatively little impact on the economy of Crawford County for several years. The average farm forest in the watershed is smaller than ten acres. Merchantable stands are few and far between. Only one out of ten stands examined was merchantable for sawtimber and less than a third of them for pulpwood.

This is largely the result of several interrelated factors. The forest type is hardwood, a poor hardwood type wherein the principal species are post oak, winged elm, and hickory. The typical forest canopy is sparse and stunted blackjack oak, post oak, and hickory. An almost closed intermediate canopy lies just below the overstory and in it are found winged elm and red cedar. Less than 5 percent of the stands studied are well stocked with desirable tree species, and even in these stands, the better stocking is usually due to a seedling understory of white oak, green ash, and eastern red cedar.

The burgeoning influence of Fort Smith is making part-time farming and absentee land ownership the rule rather than the exception. This changing pattern and character of ownership may provide the climate for the solution to the problem of uneconomic woodlands. As leisure time and affluence for the part-time farmer and his city neighbor expands, interest can and should be concentrated toward the development of the multiple role and use of their forest acreages for a profit. The city resident is already willing to pay for his recreational use of the woods. The owner needs wise and timely advice in order to be able to meet the growing water, recreation, and timber needs of the thriving Fort Smith metropolitan area. The owner's available time and money which he used to devote, in the past, to developing his woodlot has already dwindled to next to nothing. Competition for his investment time and money is high.

The effort to bring the forests into production will require a more than average expenditure of dollars and effort since over 40 percent of the stands examined would require the relatively expensive treatment of underplanting and stand conversion.

The soils in the bottomland portion of the watershed have a very high capability for crop production and are being used accordingly. Very intensive cropping systems which involve a spring and fall crop of vegetables or which combine soybeans and wheat are common. Occasionally, three crops are produced on the same land within one year. The most abundant single crops are alfalfa, soybeans, watermelons, and cantaloupes. Vegetables that are being produced include cabbage, cucumbers, peas, sweet corn, Irish and sweet potatoes, tomatoes, peppers, and squash. The total area occupied by vegetable crops is significant, even though the acreage of any individual vegetable may be small.

All of the vegetables and most of the other crops are sold commercially as opposed to being utilized on the farm. Some of the vegetables are marketed as fresh produce in Van Buren, Fort Smith, and surrounding vicinity; others are sold to canneries for processing prior to final consumption. Most of the processing of vegetables is performed locally while some are transported approximately fifty miles to canneries in northwest Arkansas.

Fort Smith and Van Buren serve as the main trade centers for the watershed and surrounding area. In addition to being the principal outlet for the agricultural commodities grown in the watershed, these cities are the primary source of production inputs and agricultural supporting services essential to the farming enterprises.

Van Buren and Fort Smith offer many other facilities and services to residents of the area. Facilities are available to fulfill practically any need for basic living necessities, finance, health and medicine, education, recreation, religion, and other social interests to mention a few. A wide variety of retail wholesale, and professional services are also available.

Facilities to satisfy any need for rail, air, or truck transportation are available closeby. Two railroads, the Missouri-Pacific and the

St. Louis-San Francisco, serve the area. The Twin Cities Public Airport which serves private and small aircraft is located in the watershed. Daily, there are 24 flights in and out of the Fort Smith Municipal Air Terminal. These flights provide connections with all major scheduled airlines. Five bus companies and fifteen truck lines maintain home or division offices in Fort Smith and provide nationwide service. Barge transport is also available due to the Arkansas River Navigation Project of the Corps of Engineers.

The road system serving the interior of the watershed consists of approximately twenty miles of highways, excluding city streets, and fifty miles of gravel, all-weather roads. The twenty miles of highways include approximately eight miles of the interstate system and twelve miles of state and county highways. This network of roads provides easy accessibility to or from any point within the watershed.

Highways in the immediate vicinity of the watershed include Interstate Highway 40, U. S. Highways 64, 71, and 271, and State Highways 10, 22, 45, and 59. This network makes the watershed accessible from all directions.

Various organizations both in Van Buren and Fort Smith have worked untiringly for the past several years encouraging prospective industries to locate plants in the area. Much success has been achieved. Over 250 manufacturing plants which employ 13,000 workers are located in Fort Smith and the combined population of the two cities increased almost 40 percent since 1950, from about 54,000 to 75,000 at present.

Even though many jobs were created in the industrial segment of the economy and the labor force contracted due to the mass exodus from agriculture and the rural area, the problems of unemployment and underemployment continue to plague the local economy. The number of unemployed persons tripled between 1950 and 1958. Unemployment, as a percent of the labor force, increased from 5.6 percent in 1950 to 19.9 percent in 1958. Since 1958, there has been a slow downward trend and in 1967, the unemployment rate was only 9.6 percent.

The seasonal nature of many jobs also contributes to this problem. In 1960, only 40 percent of the labor force worked the entire year and 26 percent worked less than half the year. In addition, the labor force is attracted to distant jobs; in 1960, 42 percent of the workers traveled outside the county to their place of employment.

Income levels can also be cited as evidence of the poverty-stricken economy. In 1960, the per capita income in Crawford County was $1,136 or 75 percent of the state average of $1,340. Of the families in Crawford County in 1960, 48 percent had less than $3,000 income; furthermore, 32 percent were forced to survive on less than $2,000 income.

These low incomes are detrimental in several respects. First, the purchasing power of individuals and families is limited. Second, the tax base is reduced which in turn limits the revenue available to finance community facilities and development projects that will benefit the public in general.

The Public Works and Economic Development Act of 1965 established criteria whereby federal financial assistance may be provided to help alleviate conditions of substantial and persistent unemployment and underemployment in economically distressed areas. This assistance is available to either redevelopment areas or economic development districts. A redevelopment area is usually a county whereas an economic development district is a multi-county area.

In December 1965, Crawford County was declared to be a redevelopment area based on the local unemployment rate and family income. Local leaders and interested citizens have formed the Crawford County Development Council which has prepared an Overall Economic Development Plan. This OEDP describes the county and its economy, identifies problems and needed adjustments, and proposes programs to alleviate the problems. One specific program mentioned is small watershed projects to prevent flooding and control erosion.

Crawford County is one of six counties comprising the Western Arkansas Economic Development District. This district was formed so that projects with a multi-county effect could be planned, sponsored, and initiated.

Crawford County is also included in the Ozarks Economic Development Region. This region is a multi-county area in Arkansas, Oklahoma, Missouri, and Kansas. This region was established under Title V of the Public Works and Economic Development Act of 1965 in order that economic development projects of broad geographical significance could be planned and carried out.

Crawford County is included in the Arkansas River Valley Resource Conservation and Development Project. This project encompasses an eight-county area and was established under the provisions of Title I of the Food and Agriculture Act of 1962. This project provides federal assistance for projects in the multi-county area that will conserve, improve, develop, or more efficiently utilize land, water, and other natural resources.

The formulation and passage of the above laws and the organization of the various groups has been for the primary purpose of expanding the economic opportunities and improving the social welfare of the residents of the area. Installation of the Flat Rock Creek Watershed Project will contribute to the objectives of the above-mentioned groups by providing employment and increasing income.

Fish and Wildlife Resource Data

There are three distinct wildlife habitats in the watershed with differing wildlife populations, as follows:

Upland: Much of the upland area is open fields with strips of woodland along stream courses. There are a few scattered woodland areas of generally low quality hardwoods. Fields are either fallow or in pasture with a few scattered cropland fields. The food and cover present is excellent for rabbits and songbirds. It is fair for quail, squirrels, doves, and furbearers.

Numerous farm ponds are scattered throughout the upland area. They provide livestock water and also fishing for thousands of local residents. Many fish from the ponds find their way to the creeks below and help maintain the stream fishery resource. There are virtually no fish in Town Branch. The main stem of Flat Rock Creek has a variety of fish. Even during droughts, pools of water occur. Fish species found in the creek include bass, sunfish, bullheads, and channel catfish.

Bottomland: Food and cover in this intensively farmed area is restricted to fencerows, turnrows, and woodlands along streams. The habitat is excellent for rabbits where cover is present. Furbearer populations are excellent along the streams. Dove and meadowlark populations are excellent in open areas. Quail and squirrel populations are confined principally to food and cover areas along fencerows and streams.

The main stem of Flat Rock Creek becomes a slow running stream in this area. In addition to the fish population in the upland area, carp and buffalo are present.

Marsh and Swamp: An extensive marsh and swamp surrounds Hollis Lake in the lower portion of the watershed. This area contains an excellent rabbit and songbird population. Doves come to the lake regularly for water. Waterfowl use the area during fall and spring migration. Shorebirds are noted throughout the year.

Fishing in Hollis Lake is not considered good. Occasionally, crappie, buffalo, and carp are caught by fishermen.

WATERSHED PROBLEMS

Floodwater Damage

There are about 1,030 acres of bottomland in this watershed that are subject to floodwater damages, as delineated by the 100-year frequency flood. The flood plain includes two separate areas: (1) 726 acres adjacent to Flat Rock Creek; and (2) 304 acres that border Town Branch.

The 726-acre flood plain of Flat Rock Creek is presently devoted, in varying degrees, to the production of agricultural commodities; however, these 726 acres include approximately 200 acres that are located within the city limits of Van Buren, Arkansas.

The flood plain of Town Branch, 304 acres, consists of approximately 242 acres used intensively for agricultural production and 62 acres of urban properties in Van Buren. Approximately 78 acres of the agricultural land are also inside of the Van Buren city limits.

Additional acreages in the flood plain of both Flat Rock Creek and Town Branch may have been annexed to Van Buren by this time. In recent years, the urban sprawl associated with the rapid development of industrial, commercial, and residential properties in and around Van Buren has engulfed considerable acreage in the vicinity of the watershed flood plain. Based on a continuation of this trend, it appears likely that urban uses will encroach on the flood plain in the future without the

the project. The damages that may result depend, in part, upon the extent of this urbanization.

The five evaluation reaches used in this analysis contain the following flood-plain area:

Reach 1: Town Branch - Hollis Lake to the Missouri-Pacific Railroad.

Reach 2: Town Branch - Missouri-Pacific Railroad to Multiple Purpose Site 1.

Reach 3: Flat Rock Creek - Hollis Lake to Interstate 540.

Reach 4: Flat Rock Creek - Interstate 540 to Missouri-Pacific Railroad.

Reach 5: Flat Rock Creek - Missouri-Pacific Railroad to Site 2.

Reach 2 contains only 62 acres of flood plain or approximately 6 percent of the watershed flood plain. This acreage consists of urban properties along Town Branch in Van Buren, Arkansas. Extensive nonagricultural damages occur in this reach indicating that the damages are more related to depth of flooding than to the area flooded. The annual storm causes significant damage, and the damages increase rapidly as the storm size increases.

On April 3, 1964, a total of 5.12 inches of rainfall occurred within a 5-hour period. A recurrence of this storm, an approximate 25-year frequency event, would cause an estimated $308,300 of direct damage to the urban properties under future "without project" conditions.

The 100-year frequency flood would produce an estimated $549,660 direct damage to the 167 urban properties that are subject to flooding. The location of the urban flood plain is shown on the Urban Flood Plain Map. As forest, grass, and idle land are replaced by urbanization, runoff will increase, thus tending to increase flood stages and consequent floodwater damages.

Reaches 1 and 3 contain 242 acres and 423 acres, respectively, of the flood plain. The combined acreage in these reaches constitutes 65 percent of the entire flood plain in the watershed. These reaches suffer frequent flooding with three to four damaging floods occurring each year. Nevertheless, both reaches are used very intensively for agricultural production. About 86 percent of the flood plain in these two reaches is used for crop production and the balance is grassland and miscellaneous uses. The frequent flooding results in severe crop and pasture damages with this intensity of production.

Reach 4 (184 acres) and Reach 5 (119 acres) are also similar and contain 29 percent of the total watershed flood plain. Flooding is frequent with an average of about two floods annually. The valley is narrower in these reaches than it is downstream and the soils are not well suited to crop

production. This accounts for the less intense operations in these reaches with cropland occupying about 46 percent of the flood plain. Grassland and miscellaneous uses account for the other 54 percent.

The variation among reaches with regard to the land use and intensity of production is reflected in the damageable value and floodwater damages. The following table presents, for the agricultural reaches, the estimated per-acre value of flood-plain production, the average annual crop and pasture damage per acre, and the average annual flood damage as a percent of the value:

Reach Number	Location	Damageable Value Per Acre (dollars)	Annual Crop and Pasture Damage Per Acre (dollars)	Percent Annual Damage
1	Town Branch - Hollis Lake to Missouri-Pacific Railroad	119.43	13.72	11
3	Flat Rock Creek - Hollis Lake to Interstate 540	137.65	21.20	15
4	Flat Rock Creek - Interstate 540 to Missouri-Pacific Railroad	73.68	13.32	18
5	Flat Rock Creek - Missouri-Pacific Railroad to Site 2	55.32	3.19	6

The other agricultural damages experienced in the watershed are relatively minor and consist of fence damages in Reaches 4 and 5. There are no other agricultural damages in Reaches 1, 2, or 3.

All of the nonagricultural damages that occur are the urban damages in Reach 2 which have already been discussed.

Indirect damages that occur as a result of actual or threatened flooding include the interruption of travel, loss of income by workers who commute, loss or delay of sales by local merchants, and the additional time, distance, cost, and general inconvenience associated with marketing farm products, delivering mail, and transporting children to school. Indirect damages also occur in Van Buren when families evacuate their homes during a flood threat and purchase food, lodging, etc. The costs incurred by businessmen during a flood threat to move or elevate damageable merchandise is an indirect damage if the flood does not materialize.

Major floods are defined as those which overflow 50 percent or more of the area inundated by the 100-year storm. The severity of flooding in the agricultural reaches (1, 3, 4, and 5) is substantiated by the fact that the 2-year frequency storm inundated 49 percent of the entire flood plain in these reaches. Of the total agricultural damages produced during the 100-year evaluation period, the majority are caused by small frequent floods. Floods up to and including the 2-year frequency account for approximately 76 percent of the total agricultural damage from all floods.

A typical major flood occurred in April 1964. This storm approximated the 25-year frequency event and inundated approximately 880 acres of the flood plain. The total damage caused by this storm is estimated to be $378,300 and includes: crop and pasture, $20,300; nonagricultural, $308,300; other agricultural, $600; and indirect, $49,100.

The average annual floodwater damages (table 5) amount to $141,070 and are accounted for by $17,280 crop and pasture, $104,720 nonagricultural, $250 other agricultural, and $18,820 indirect.

Sediment Damages

Sediment damages at one time were widespread in the southwestern one-fourth of the watershed. Arkansas River overflows extended from Van Buren southeastward beyond the Flat Rock Creek Watershed outlet. These overflows, which contributed large quantities of relatively infertile sand to the flood plain of Town Branch and Flat Rock Creek, have now been eliminated by flood-control projects. Damaging sediment from the uplands of the watershed are now of minor importance in comparison with floodwater damage and were not used in the economic evaluation of the watershed. Swamping is also a minor problem.

Erosion Damage

Physical valley damages caused by channel and sheet scour have affected small acreages to the extent of 10 to 15 percent damage. This is a minor watershed problem and is of little economic significance in project development. Streambank erosion is not a serious problem and land voiding caused by erosion is considered to be negligible.

Problems Relating to Agricultural Water Management

About 600 acres of the watershed are poorly drained. The drainage problem has been adequately solved on most of this area by local landowners and operators working individually and in small groups. The remaining need for drainage is limited and can be alleviated under the going program that is presently available.

About 3,000 acres are presently being irrigated in the watershed. An abundant supply of underground water at shallow depths is available for irrigation and domestic use. The supply of water from this source is more than adequate to fulfill the needs of the foreseeable future. No facilities for irrigation are included in this plan.

Facilities in the immediate vicinity that provide water-based recreation are not adequate to meet the demands of the local residents. The Arkansas River is available for boating, fishing, etc., and a small private lake located near the northern edge of Van Buren provides fishing on a user fee basis. A large number of potential users are included among the 75,000 residents of Van Buren and Fort Smith. Additional sources of water would improve the recreational opportunities in the watershed and add to the quality of living in the area.

Uncontrolled and indiscriminate grazing has virtually eliminated the effectiveness of the water-holding and retentive capacities of the forest floors of about 2,400 acres of forest land. This damage is often so severe that moderate sheet and rill erosion is occurring on about a quarter of these same 2,400 acres. Little hope for improvement in the forest hydrologic condition can be expected unless an effective program of cattle exclusion is effected.

As the City of Van Buren extends its boundaries, a significant land treatment problem will be that of reducing erosion during the time bare soil is exposed during construction operations. Specific erosion control measures will be required to prevent soil loss. The soil and water conservation district and municipal officials will work closely together to achieve applications of needed measures.

PROJECTS OF OTHER AGENCIES

The Corps of Engineers has provided many improvements in the Arkansas River Basin under various authorizations by Congress since the first authorization in the Flood Control Act of 1948. Construction of Lock and Dam 13 on the Arkansas River has been completed. This structure, which is one of a series of seventeen locks and dams which are being constructed to make the Arkansas River navigable, is located downstream from the old outlet of the Flat Rock Creek Watershed.

In order to mitigate the adverse effect which the construction of this lock and dam would have on the interior drainage within the Flat Rock Creek Watershed, the Corps of Engineers constructed a new outlet channel. This channel starts at the lower end of Hollis Lake and extends about one and one-half miles southeast and then outlets through a box culvert through the Crawford County Levee into an open ditch which flows into the Arkansas River. The channel provides an adequate outlet for the Flat Rock Creek Watershed.

PROJECT FORMULATION

The sponsors of the watershed project recognize the need for a comprehensive approach to the watershed problems. They have formed the Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, under Act 197 of the Acts of the General Assembly for the State of Arkansas for 1937, as amended. The formation of this improvement project area provides the means by which the landowners and operators may collectively assume the responsibilities for flood prevention under Public Law 566 and demonstrates their ability and willingness to assume these responsibilities.

The unstable economic conditions of the area have been recognized by the sponsors. This Public Law 566 project has been formulated to adequately meet the sponsors' objectives of watershed protection, flood prevention, and recreation. The planned improvements will increase farm profits, provide agricultural and nonagricultural jobs, stabilize incomes, and improve living conditions within the watershed. It is believed these changes will tend to enhance the economic tone of the area.

After consideration of the needs of the community for resource development, economic growth, and the physical capabilities of the watershed, the following objectives of the watershed sponsors were agreed upon:

1. To install needed land treatment measures which will increase the efficiency of land use and obtain maximum benefits from the proposed improvements.

2. To install structural measures which will provide flood protection for:

   a. the agricultural flood plain which is subject to frequent damaging floods and reduce the damage from these floods at least 80 percent; and

   b. the City of Van Buren by controlling the flooding from the 100-year frequency storm.

3. To install a multiple purpose structure (flood prevention and recreation), the recreational purpose to be sponsored by the City of Van Buren, Arkansas.

4. To provide for maximum feasible protection for fish and wildlife resources.

5. To provide drop structures and other appurtenances to the channels, as may be required, to protect them from excessive streambank erosion and channel aggradation.

6. To install a system of land treatment and structural measures which will provide an acceptable level of protection at the lowest cost considering the installation, operation, maintenance, and replacement costs.

7. To make the watershed an outstanding example of soil and water conservation.

An analysis of the land treatment data provided by the Soil Conservation Service local work unit office indicated that the land treatment goals which had been agreed upon were realistic and could be accomplished during the 5-year installation period if Public Law 566 funds for additional technical assistance and forest fire control equipment were provided as part of this project.

The forest land treatment program was developed from information acquired during a field survey of the watershed, subsequent consultation by the Arkansas Forestry Commission and the U. S. Forest Service, and from land use recommendations by the Soil Conservation Service. This program is based on the needs beyond those met by the existing cooperative federal-state forestry programs. The goals are realistic and can be accomplished during the 5-year installation period. Public Law 566 funds for accelerated technical assistance are provided as part of the project.

The 1969 Arkansas fire loss index goal is 0.47 percent and the watershed protection goal is 0.20 percent. The average percent burn for the years 1965 through 1969 was 1.10 percent, exceeding both goals. A fire prevention contactor program will be set up to strengthen the prevention efforts in the watershed.

Areas that are being or will be converted to urban use are recognized by the sponsors as sources of potentially damaging sediment. The sponsors intend to cooperate fully with all agencies and groups that can assist in providing the necessary legislation and technical knowledge to control this problem. The development of good plans for drainage and runoff water disposal for severely damaged urban areas will be a byproduct of the passage of enabling legislation.

It was determined early in the project formulation stage that it would be necessary to build floodwater retarding structures at all feasible locations in order to provide the desired level of protection from flooding and to limit the extent of needed channel improvement. In addition to the two structures which are planned as part of this project, a survey and preliminary design were made for a structure to be located on Neal Prairie Creek. The required floodwater storage could not be obtained at this location, so this structure was eliminated. Detailed channel studies were made to determine stability and to develop the design which would be the least harmful to fish and wildlife resources within the watershed. Special consideration was given to the needs of Hollis Lake.

An ungated port is planned in Structure Number 2 to provide a constant release of water into Flat Rock Creek at all times except during periods of extreme drought. This release was provided as a mitigation measure for fish and wildlife resources; however, it will actually result in an increased flow in the stream about 90 percent of the time.

A number of systems of structural measures were analyzed to determine which was the most feasible. It was found that channel improvement on both Town Branch and Flat Rock Creek would be required. The system, as shown in this plan, proved to be the most feasible. It provides one multiple purpose structure (flood prevention and recreation), one single purpose structure, and approximately 7.4 miles of channel improvement. The measures planned for Town Branch do not provide complete urban flood protection from the 100-year storm; however, a maximum depth of flooding of about one foot is to be expected in the future.

These structural measures provide the highest level of protection which it is feasible to provide. The sponsors have agreed that the urban protection is adequate. The installation of the measures proposed in this plan will meet all other project objectives.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program is necessary for a sound program of watershed protection and flood prevention. The basic objectives of the

conservation program are the use of each acre of land within its capabilities and treatment with conservation practices in accordance with its needs for production and improvement in the proper use. The land treatment measures already installed (table 1A) show that watershed landowners and operators are currently utilizing conservation practices in their farming operations.

During the 5-year project installation period, emphasis will be placed on the acceleration of the program currently being conducted by the soil and water conservation district. The land treatment practices which will be installed constitute the only planned measures for protection of the upland areas. These measures will improve soil and cover conditions, reduce runoff, and reduce the volume of sediment delivered to the floodwater retarding structures.

The acres to be treated and the estimated cost of the land treatment measures to be installed are given in table 1. These measures will be established and maintained at the expense of individual owners and operators. Land treatment measures are planned for 3,000 acres of cropland and consist of conservation cropping systems, contour farming, and crop residue management.

About 3,500 acres of grassland will receive land treatment measures and practices including pasture and hayland planting, pasture and hayland management, brush control, deferred grazing, and proper grazing use.

Wildlife habitat management is planned for about 230 acres to improve the cover conditions and increase the food supply for upland game. Wildlife wetland management is planned for 650 acres in the watershed.

Fish and wildlife development will be an important part of conservation plans of cooperators of the Clear Creek Soil and Water Conservation District. Fish pond management in farm ponds, stocking with fish and management of the two structures, management of upland game habitat, recreational developments, and food patches for wildlife will all receive timely attention.

Structural conservation practices, supplementary to the soil and cover improving measures, will include 7,000 feet of diversions, 3,500 feet of terraces, 300 acres of land smoothing, 4,000 feet of drainage mains and laterals, 5,000 feet of drainage field ditches, five structures for water control, and 25 farm ponds.

To accelerate the planning and establishment of the land treatment phase of the project, $7,500 of Public Law 566 funds for technical assistance will be provided in addition to that which is presently available. About $2,500 of these funds will enable standard soil surveys to be completed on 10,000 acres of the watershed. It is estimated that 9,000 acres will be mapped with funds from the going program.

The forest land treatment measures are proposed in order to effectively reduce runoff and erosion. Proper forest management and protection will produce under each managed stand a well-developed layer of humus which

will improve the soil's basic infiltration rate and water-storage capacity. Favoring humus-building tree species along with game food-bearing and den trees during cutting operations and interplanting with the same or similar species will not only assure the development of well-aggregated soils and maintain an effective litter and humus layer but also accelerate the development of a varied and productive wildlife habitat. An aggressive fencing program is proposed to protect existing and future forest stands from further grazing destruction; tree planting and stand improvement operations will not be performed unless the tract is protected from grazing.

Accelerated technical assistance to the landowners in the watershed will result in effective forestry practices applied to the forest lands. In harmony with sound watershed management, forest lands will be managed to fulfill wildlife, recreation, timber, and other environmental requirements. Forest management goals will be directed to attain the most desirable forest succession type.

The primary use on about 300 acres of woodland on 18 farms is being designated as wildlife land by their owners. The soil and water conservation district and the Arkansas Forestry Commission plan to work closely in developing a forest land treatment program that will most effectively establish and maintain forest wildlife habitat.

The planned forest land treatment measures include about 900 acres of noncritical tree planting, 1,900 acres of stand improvement, and fire prevention measures for all the forested lands.

(1) Tree Planting - Watershed Protection (900 acres) - Reforestation of 900 acres of understocked stands is required not only to adjust land use up to its capability but also to reduce runoff and erosion by producing a protective forest canopy and an absorbent forest floor of a spongy humus layer under a protective layer of litter.

(2) Stand Improvement Measures (1,900 acres) - These are silvicultural measures designed to improve the forest's hydrologic capabilities by adjusting the stand composition which will produce the optimum development and protection of forest cover, litter, and humus. These practices include improvement cuttings, tree release, inferior species and cull removal, and others.

Projected urban and industrial development will create an erosion and sediment problem over and above that expected for an agricultural watershed unless special erosion control measures are applied by builders during construction. Some measures that may become necessary are temporary debris and desilting basins, seeding and mulching exposed soil, temporary diversion of runoff, forested buffer zones, infiltration zones, and sediment-trapping areas. These special measures do not preclude protection and management of existing woodland within the urban influence before, during, and after development. Urban land treatment measures involve 400 acres undergoing urban development, 1,600 acres already in urban development, and 80 acres of forest land. Projections indicate that about 80 acres of forest land will be converted to urban use during the installation period.

Areas disturbed by project construction will be promptly revegetated with plants of maximum value to wildlife for food or cover or both in the form of grasses, forbs, shrubs, and trees, whichever is the most effective in the long run.

Structural Measures

Structural measures consist of one multiple purpose structure (flood prevention and water resource improvement for recreation), one floodwater retarding structure, and approximately 7.4 miles of channel improvement (see project map, figure 4).

The total estimated installation cost for the structural measures is $3,607,658.

The total drainage area above the proposed dams is 5.53 square miles, representing 19 percent of the entire watershed.

The two structures have an aggregate storage capacity of 2,301 acre-feet. Floodwater storage is 1,943 acre-feet. Water resource improvement for recreation storage is 109 acre-feet. Sediment storage which provides for 100-year accumulation is 249 acre-feet.

Multiple Purpose Structure Number 1 which is being built in cooperation with the City of Van Buren, Arkansas, will provide for 109 acre-feet of storage for water resource improvement for recreation in addition to 37 acre-feet of submerged sediment which is expected to accumulate during the 100-year life of the structure. An additional 2 acre-feet of sediment is expected to accumulate in the flood pool. Floodwater detention storage is 152 acre-feet or 8.0 inches, expressed in inches of runoff from the drainage area above the structure. The recreation pool will have a surface area of 11 acres. An additional 9 acres will be subject to temporary inundation by the floodwater pool. Multiple Purpose Structure Number 1 is located in the City Park of Van Buren and will be open to the public. Adequate sanitary facilities are available at the present time.

The principal spillway crest elevation of Floodwater Retarding Structure Number 2 was raised to the 100-year submerged sediment level to provide storage to mitigate the anticipated stream fishery losses below the structure in addition to providing for the first 50-year submerged sediment storage. The mitigation storage will be released through an ungated port at the first 50-year sediment pool level to maintain a continuous flow downstream. The submerged sediment expected to accumulate during the first 50 years is 102 acre-feet and 94 acre-feet during the second 50-year period. An additional 14 acre-feet of sediment is expected to accumulate in the flood pool. The 50-year sediment pool will inundate 20 acres. Eleven acres will be subject to long periods of inundation by the mitigation storage and an additional 114 acres will be subject to temporary inundation by the flood pool. Floodwater detention capacity is 1,791 acre-feet, or 6.48 inches, expressed in inches of runoff from the drainage area above the structure.

The present land use of the sediment pool, fill, and emergency spillway area of Floodwater Retarding Structure Number 2 consists of approximately 35 acres of pastureland and 17 acres of woodland.

The installation of Floodwater Retarding Structure Number 2 will require the relocation of one dwelling and one farm operation.

Both structures will have principal spillways consisting of a two-stage concrete riser with a reinforced concrete conduit through the fill. A drain valve will be included in the principal spillway to facilitate the installation of the dam by disposal of runoff during construction and to drain the impoundment as needed for repairs. Incidental use of this drawdown device will include manipulation of water levels for aquatic weed control. It will also provide for fish management operation, exposure of shallow edges for waterfowl plantings, and the means to supply water downstream for emergency use. The dams will be earth fill structures which consist of a cohesive core material, a rock shell, and an intervening filter of graded material. Adequate borrow material will not be available in the pool areas and approximately 11 acres of offsite borrow on Site Number 1 and 18 acres on Site Number 2 will be required for the embankments. These areas are expected to supply about 115,000 cubic yards on Site Number 1 and 298,000 cubic yards on Site Number 2. Suitable borrow areas are located about one-quarter mile downstream and also one-quarter to one-half mile north of Site Number 1. All of the offsite borrow material needed on Site Number 2 can be obtained from the flood pool area immediately above the sediment pool.

The emergency spillway on Multiple Purpose Structure Number 1 is on the left abutment and on Floodwater Retarding Structure Number 2, it will be in a topographic saddle above the left abutment. Both of the emergency spillways will be vegetated and will release runoffs exceeding the reservoir storage away from the embankment.

All earth fills, emergency spillways, and offsite borrow areas will be fenced where needed to protect vegetation. Offsite borrow areas will be restored by vegetative measures and erosion control structures.

All applicable state and local laws will be complied with in the design and operation of these structures.

Improvement of Channel Number 1 will consist of 1.0 mile of clearing and snagging and 3.2 miles of channel enlargement. The clearing and snagging will consist of incidental clearing and debris removal to insure the design capacity. The channel improvement will increase the capacity of the channel to provide full protection to the urban area for the 100-year storm. The channel enlargement consists of increasing the depth and/or width of the existing channel. Reinforced conrete-lined channel will be utilized through the residential area of Van Buren to reduce the necessity for encroaching upon high-valued residential property.

The channel will be excavated from one side where feasible and the spoil will be spread. Spoilbanks and berms in selected areas will be vegetated to hasten stabilization of the soil. Ditch side slopes will be sprigged with bermudagrass to hasten stabilization of the soil. Channel

construction contracts will be completed in early spring when feasible to provide a full growing season immediately following construction. Approximately 16 grade stabilization structures will be installed as appurtenances to the channel improvement in side drains where needed for grade stabilization, erosion control, and to facilitate inspection and maintenance.

Approximately 3.2 miles of Channel Number 2 will be improved by removing debris and clearing in restricted areas to provide an adequate capacity to carry the approximate 1-year peak discharge.

Access roads for maintenance will be provided by smoothing the berm or spreading spoil along at least one side of each channel to permit travel by maintenance equipment.

Studies of the earth channel sections indicate that stability from the standpoint of runoff flow will not be a problem. Both channels contain no appreciable bedload. Bedrock will not be encountered in any of the planned excavation. Channel bank and bottom materials on Channel Number 1 were sampled at thirteen locations and analyzed for size distribution and plasticity. The materials are nonplastic to slightly plastic with plasticity indexes ranging from 0 to 8; D_{75} sizes range from 0.175 mm to 0.54 mm. Of the thirteen samples, two are classified as ML, seven are SM, and four are SP.

Based on the permissible velocities procedure in Technical Release 25, the lowest computed allowable velocity of 1.9 feet per second will not be exceeded. A changed condition in the groundwater table could present a stability problem during the construction of Channel Number 1. The problem is created by the elevated water table created by Lock and Dam 13 on the Arkansas River. Preliminary studies, investigations, and information supplied by the Corps of Engineers and the U. S. Geological Survey indicate that the water table will be slightly above the elevation of the bottom of Channel Number 1. An estimate of the rate of return flow into the channel is 15 cfs. This volume of water is not significant, but the SM and SP material which would have to be excavated will be completely saturated resulting in a possible bank stability problem. Therefore the depth of excavation on Channel Number 1 will be limited to elevation 392.0 feet mean sea level to minimize seepage from the Arkansas River. This revised design would allow the phreatic line of the water table to slope toward the channel and would intersect the channel at grade. Stability is not expected to be a problem once vegetation on the banks is established.

More detailed information on quantities, costs, and design features is given in tables 1, 2, 2A, 3, and 3A.

EXPLANATION OF INSTALLATION COSTS

The total installation cost of the project is estimated to be $ 3,856,818 of which $3,142,400 will be paid from Public Law 566 funds and $714,418 will be borne by other funds. Included in the total costs are $249,160 for land treatment measures and $3,607,658 for structural measures

Land treatment costs will be shared $29,700 by Public Law 566 funds and $219,460 by other funds. Public Law 566 funds will provide $5,000 for technical assistance to accelerate the installation of land treatment measures on all lands other than forest land and $2,500 for soil surveys. Other funds will include $4,200 for technical assistance and $2,500 for soil surveys through the regular program of Public Law 46.

The costs of installation of the forestry phases of the private land treatment program were developed by the U. S. Forest Service and the Arkansas Forestry Commission. The technical assistance costs were based on the present costs of the going Cooperative Forest Management Program. Installation costs are based on present prices being paid by landowners or operators to establish similar measures in the locality. The private forest land treatment measures needed to meet treatment goals were developed from the field survey of the watershed and were adjusted for expected landowner participation during the installation period.

The estimated cost of the forest land treatment program is $118,060. Of this amount, $22,200 are Public Law 566 funds and $95,860 are from other sources. The Public Law 566 funds are for accelerated technical assistance.

The U. S. Forest Service, by and through the Arkansas Forestry Commission, will provide $3,500 for accelerated technical assistance. The going Cooperative Forest Management Program will provide additional technical assistance valued at $60. The going Cooperative Forest Fire Control Program will provide additional assistance for the protection of the watershed through capital outlay acceleration valued at $1,800 during the length of the installation period.

The landowners and operators will furnish the $90,500 (which includes $3,400 assigned to Cooperative Forest Fire Control) required for the installation of the forest land treatment measures on their land.

The Use of Facilities Method was used to allocate joint costs between purposes in Multiple Purpose Structure Number 1. This resulted in an allocation of 63.67 percent to flood prevention and 36.33 percent to water resource improvement for recreation. The City of Van Buren, Arkansas, will bear 50 percent of the construction cost allocated to the water resource improvement for recreation and all costs of obtaining land rights. Public Law 566 funds will bear 50 percent of the construction cost allocated to flood control and all of the engineering services.

All costs of Floodwater Retarding Structure Number 2 and all channel improvement were allocated solely to flood prevention. Public Law 566 funds will bear all construction costs, and engineering services. The Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, will bear all costs of obtaining land rights.

The Soil Conservation Service will bear 100 percent of the first $25,000 of relocation payments costs for persons and farm operation displaced at Floodwater Retarding Structure Number 2 prior to July 1, 1972. Any such cost for a single dislocation in excess of $25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be

shared 81.46 percent by Public Law 566 funds and 18.54 percent by the Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District.

The estimated cost of structural measures will be shared $3,112,700 by Public Law 566 funds and $494,958 by other funds. The cost-sharing responsibility, other than project administration, results in the following distribution of cost:

Multiple Purpose Structure Number 1

Public Law 566 funds were estimated to be $199,393 which includes $180,241 for construction cost and $19,152 for engineering services. Other funds were estimated to be $79,209 which includes $40,009 for construc- cost and $39,200 for land rights.

Floodwater Retarding Structure Number 2

Public Law 566 funds were estimated to be $373,357 which includes $340,000 for construction cost, $30,357 for engineering services, and $3,000 for relocation payments for one family and one farm operation. Other funds will pay $131,800 for land rights costs.

Channel Improvement

Public Law 566 funds were estimated to be $2,078,249 which includes $1,907,901 for construction cost and $170,348 for engineering services. Other funds will pay $272,550 for land rights.

All Structural Measures

Public Law 566 funds were estimated to be $2,650,999 which includes $2,428,142 for construction cost, $219,857 for engineering services, and $3,000 for relocation payments. Other funds were estimated to be $483,559 which includes $40,009 for construction cost and $443,550 for land rights cost.

Included in the construction cost is approximately $23,000 for the purchase of offsite borrow material and the establishment of vegetative cover on designated borrow areas.

Included in land rights costs to be paid by other funds are $140,000 for the reconstruction and modification of two structures under the Missouri-Pacific Railroad, $78,400 for road and

bridge relocation, $10,000 for additional cost of closed conduit under the parking lot at Nation's Drive-In, $31,850 for utility line relocation, and $28,000 for fencing along the concrete-lined channel where needed for the protection and safety of the public, and $23,000 for the relocation of three buildings.

Project administration is estimated to be $473,100. Of this, Public Law 566 funds will pay an estimated $461,701 and other funds will pay approximately $11,399. Project administration costs are the Public Law 566 and other administrative costs associated with the installation of structural measures. These costs are treated as project costs but will not be considered as applicable to individual purposes served by the project nor are they a part of the cost of individual measures. Public Law 566 funds will pay an estimated $219,858 for construction inspection, $219,857 for other administrative cost, and $21,986 for contract administration. The City of Van Buren will pay an estimated $958 for administrative cost and the Clear Creek Soil and Water Conservation District through the improvement project area will pay an estimated $11,399 which includes $10,035 for administrative cost and $406 for relocation advisory assistance service. The relocation assistance measures shall provide services as may be necessary to determine the need of displaced persons for relocation assistance, provide current information on adequate housing and locations for displaced farming operations, assist displaced persons in obtaining and becoming established in a suitable replacement location, supply information concerning federal and state programs offering assistance to displaced persons, provide outline of benefits to which they may be entitled, and provide other advisory services to displaced persons to minimize hardships to such persons in adjusting to relocations.

Construction cost estimates were based on computation of quantities derived from survey data using unit costs of similar work on other projects.

The engineer's cost estimate and contingency allowance of 12 percent is considered realistic and provides a reasonable allowance for unexpected costs.

The estimated schedule of obligations for the 5-year project installation period covering the installation of both land treatment and structural measures is as follows:

Schedule of Obligations

Fiscal Year	Measures	P. L. 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment Measures	3,700	24,000	27,700
	Engineering Services	70,000	-	70,000
	Land Rights Cost	-	75,000	75,000
Second	Land Treatment Measures	6,000	43,000	49,000
	Engineering Services	60,000	-	60,000
	Construction: Multiple Purpose Structure Number 1	180,241	40,009	220,250
	Construction: Channel Improvement	600,000	-	600,000
	Land Rights Cost	-	315,000	315,000
Third	Land Treatment Measures	6,000	43,000	49,000
	Engineering Services	60,000	-	60,000
	Relocation Payments	3,000	-	3,000
	Construction: Floodwater Retarding Structure Number 2	340,000	-	340,000
	Construction: Channel Improvement	800,000	-	800,000
	Land Rights Cost	-	53,550	53,550
Fourth	Land Treatment Measures	8,000	60,000	68,000
	Engineering Services	29,857	-	29,857
	Construction: Channel Improvement	507,901	-	507,901
Fifth	Land Treatment Measures	6,000	49,460	55,460
Subtotal		2,680,699	703,019	3,383,718
Project Administration		461,701	11,399	473,100
TOTAL		3,142,400	714,418	3,856,818

This schedule may be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desirable and in the light of appropriations and accomplishments actually made.

EFFECTS OF WORKS OF IMPROVEMENT

Installation of the combined land treatment and structural measures will provide benefits to about 1,030 acres of flood-plain land. Direct flood prevention benefits will accrue to the owners and operators of 30 farms and about 167 urban properties. This includes 16 commercial properties, 4 industrial properties, and 147 residential properties. The area inundated by the 100-year frequency flood will be reduced from 1,030 acres to 658 acres. This is a reduction of 378 acres or 37 percent. The average annual area flooded in the watershed will be reduced 76 percent, from 766 acres to 181 acres.

The benefited area is composed of two separate units: (1) Flat Rock Creek, 726 acres; and (2) Town Branch, 304 acres. The benefited area of Flat Rock Creek is primarily agricultural land. The Town Branch unit contains, in addition to agricultural land, about 62 acres of urban properties in Van Buren, Arkansas.

Due to the diverse nature of the Flat Rock Creek and Town Branch units, the level of protection and the general effectiveness of the project also differs. The following table provides a comparison of the present and "with project" average annual area flooded and the percent reduction by reaches for each unit:

Reach Number	Location	Average Annual Acres Flooded: Without Project	Average Annual Acres Flooded: With Project	Percent Reduction
	Town Branch Unit			
1	Hollis Lake to Missouri-Pacific Railroad	174	3	98
2	Missouri-Pacific Railroad to Site 1	39	0	100
Subtotal		213	3	99
	Flat Rock Creek Unit			
3	Hollis Lake to Interstate 540	396	135	66
4	Interstate 540 to Missouri-Pacific Railroad	119	41	66
5	Missouri-Pacific Railroad to Site 2	38	2	95
Subtotal		553	178	68
TOTAL		766	181	76

The 100-year frequency flood on the Flat Rock Creek unit will be reduced from 726 acres to 544 acres or 33 percent by installation of the project. The project will reduce the probability of a major flood from 50 percent to approximately 14 percent. The 1-year frequency storm, which presently inundates 225 acres will be reduced to only 19 acres. The average annual area flooded on Flat Rock Creek will be reduced 68 percent from 533 acres at present to 178 acres with the project.

Installation of the project will virtually eliminate the flooding and damages that occur in the Town Branch unit. Urban flooding by the 100-year frequency storm will be reduced from 62 acres to 14 acres, a reduction of 78 percent. Whereas this size storm presently damages 167 residential and commercial establishments, only 12 properties will receive damage with the project installed. The properties to receive damage after the project is installed include one industrial property and eleven residential properties. Damage from the 100-year frequency storm will be reduced 99 percent, from $549,660 to $3,910. The average annual urban damage will be reduced 99.8 percent.

The agricultural segment of the Town Branch unit, Reach 1, will receive a 100-year level of flood protection on 148 acres or 61 percent of the present flood plain. The point where flooding begins will be reduced from the present 400-percent chance storm to approximately the 6-percent chance with the project, and average annual flooding will be reduced 98 percent.

The April 1964 flood, an approximate 25-year frequency storm, would be reduced 47 percent in area inundated, and the total damage from this storm would be reduced 96 percent. Damages from this size storm would be reduced from $378,300 to $15,100. Urban damages in Van Buren would be reduced about $307,500. The total reduction in damage of about $363,200 for this flood represents a benefit of about $45 for each of the 8,000 watershed residents.

The City of Van Buren agrees to annually publicize information concerning the area of continuing flood risk along Town Branch and to discourage further construction or reconstruction in the area that is subject to flooding.

The watershed project will help alleviate the remaining drainage problems in the watershed in two ways: (1) the project will decrease peak flows, thereby improving the outlet for farm drainage; and (2) the land treatment phase of the project includes mains and laterals, field ditches, land smoothing, etc.

Agricultural enhancement benefits will be realized as a result of the project. The flood-plain operators have indicated that with adequate protection against flooding, higher value uses will be adopted and greater amounts of fertilizer and other production inputs will be utilized. Benefits will be realized in the form of increased net income from the farming enterprises. Changed and intensified land use is expected to occur on about 111 and 312 acres, respectively of the flood plain.

Urban enhancement benefits will also accrue following project installation. A 100-year level of protection will be provided to about 330 acres. This protection will greatly enhance the potential for industrial development and it is anticipated that changed land use, from agriculture to urban-industrial, will occur on this protected flood plain.

Environmental enhancement effects will also be realized in the lower portion of the watershed by prolonging the life of Hollis Lake by approximately 39 years. An extensive marsh and swamp which surrounds Hollis Lake contains an excellent rabbit and songbird population. Doves come to the lake regularly for water, and waterfowl use the area during the fall and spring migration. Shorebirds are noted throughout the year. Although fishing in Hollis Lake is not considered good, occasionally crappie, buffalo, and carp are caught by fishermen.

The inclusion of storage in Multiple Purpose Structure Number 1 for water resource improvement for recreation will furnish fishing, boating, frog-gigging, picnicking, and other recreational opportunities for local residents and visitors.

Application of the planned forest land treatment measures will not only markedly reduce the runoff, erosion, and sediment problem but will also enhance recreation, wildlife, and wood production values. Well-managed forests will contribute significantly to the aesthetic and environmental aspects of urban and rural living in the watershed. Timely application of technical knowledge and assistance will achieve good drainage and surface water removal in areas being converted to urban use, thereby economically eliminating problems now so common in our cities.

This project will serve as an immediate stimulus to the local economy by providing new employment opportunities during the construction period. This effect of the project is particularly significant due to the high rate of unemployment and underemployment in the local area. The use of local labor for operation and maintenance of the project features will provide a continuing favorable effect on the local economy.

Secondary benefits from several sources will be realized when the project is installed. Additional income will be received by the laborers employed during construction and by farmers from the increased sales of farm products as a result of damage reduction and agricultural enhancement. Also, the increased purchases of items or services required to produce and market the expanded production represents new income to local farm supply dealers, transporters, processors, etc. The urban enhancement resulting from flood protection will provide landowners, developers, building material suppliers, and laborers with added income.

This new income will generate additional consumer expenditures for basic necessities, items which improve their standard of living, or other goods and services. These expenditures will initiate a chain of spending whereby each successive recipient spends a portion of the amount received. Business activity in other sectors of the local economy will increase as this new income is spent and respent.

The improved economic climate will enable the community to better support new or improved schools, parks, roads, health facilities, and other public projects that will add to the enjoyment of life.

Knowledge of the protection afforded by the project will give the residents a greater sense of security. Families can offer their children greater incentives to continue their education and remain in the community. The family-farm pattern of agriculture will be strengthened which will help maintain the recent population gain.

The various effects of the project will contribute to the goals of the Arkansas Valley Resource Conservation and Development Project, the Crawford County Development Council, the Western Arkansas Economic Development District, and the Ozarks Economic Development Region.

In essence, the project will have a profound impact on the economic growth and development in the community.

Outdoor Recreation

The two structures will provide a substantial check on surface runoff from tributary streams. Unchecked surface runoff erodes and carries large

amounts of soil from watershed slopes. It produces quick and erratic streamflow surges that scour streambeds and tear banks. Such surges, laden with sediment, are harmful to fish and aquatic stream organisms. They destroy fish foods and impair or even obliterate spawning beds.

The multiple-purpose structure in the City Park will be open to the public. It is expected that the area will receive heavy recreational use and will add greatly to the quality of living in the area. Based on previous experiences of recreational use of this type of structure in Arkansas, the present population and trends, the area available, facilities, convenience, capacity, and seasonal trends in use, the following use, without site deterioration, is anticipated in the Town Branch structure:

Recreational Use	Visitor-Days Per Year
Sightseeing	6,000
Fishing	800
Picnicking	3,000
Boating	500
Frog Gigging	50

The peak season of recreational use will occur from May 30 to Labor Day. Daily capacity during this period is estimated at 200 persons.

Floodwater Retarding Structure Number 2 has potential for incidental recreation. Before this potential is developed, it will be necessary to install sanitary facilities at the site.

The ungated port in Floodwater Retarding Structure Number 2 on the main stem will provide continuous release of water from the reservoir. During certain periods, this release will augment the streamflow in the main stem. This means there will be flowing water between pools during drought periods, pool areas will be flushed, and pools will have slightly higher water levels. This will benefit both stream fish and aquatic life in the stream.

Conservation plans that include farm ponds and wildlife habitat management should improve the fishing in the watershed area. Food, cover, and water provided should result in slightly higher upland game populations. The structures will enhance the fishing of the area, provide additional habitat for waterfowl and shorebirds, and other recreational activities not already mentioned.

PROJECT BENEFITS

The total estimated benefits accruing to the structural measures included in this plan amount to $273,670 annually. Of these benefits, $134,210 are damage reduction, $8,460 are agricultural enhancement, $40,700 are urban enhancement, $10,350 are recreation, $20,550 are redevelopment, and $59,400 are secondary.

The general location of the damage reduction benefits attributed to the combined project of land treatment and structural measures is presented in the following tabulation:

Reach Number	Location	Average Annual Damage: Without Project (dollars)	With Project (dollars)	Reduction (percent)
1	Hollis Lake to Missouri-Pacific Railroad	3,530	50	99
2	Missouri-Pacific Railroad to Site 1	122,070	530	99
3	Hollis Lake to Interstate 540	11,630	4,110	65
4	Interstate 540 to Missouri-Pacific Railroad	3,380	800	76
5	Missouri-Pacific Railroad to Site 2	460	20	96
Total		141,070	5,510	96

The damage reduction benefits include $1,350 that are attributable to the installation of the land treatment measures. These benefits were excluded from those used in project justification.

The reduction in frequency and depth of flooding will enable the farmers to increase their net farm income an estimated $8,460 annually. These benefits are accounted for by changed land use, $4,560, and more intensive land use, $3,900. The agricultural enhancement benefits were discounted to allow for the appropriate lag in accrual.

It is anticipated that urban enhancement benefits arising from the conversion of agricultural land to industrial uses will amount to $40,700 annually. These benefits are based on the increase in value of the land from its present use to its potential use, less the associated development costs. These benefits will accrue only on the area protected from the 100-year frequency flood.

The benefits which will result from the recreational use of Multiple Purpose Structure Number 1 are estimated to amount to $10,350 annually.

Crawford County's eligibility under the Public Works and Economic Development Act of 1965 as an area of low income and high unemployment was the basis for claiming redevelopment benefits. Benefits of about $20,550 will accrue annually from the use of local unemployed and underemployed labor in the construction and operation and maintenance of the project.

Secondary benefits attributable to the project are estimated to be $59,400 annually. These benefits represent the effect of the initial and successive rounds of spending made possible by the additional income created by the project. These benefits are based on additional income from employment of local laborers during construction and for operation and maintenance; the sales of greater quantities of farm products or products having higher values; the increased sales of local farm supply dealers, transporters, processors, etc., who provide production inputs or other items or services required to produce and market the increased quantity of goods; and the income generated in other sectors of the local economy by the increased business activity as this new income is cycled through the economy. These benefits are not based on indirect benefits, contain no duplication of other benefits, and are adjusted to account for the portion of the new income spent outside the local area.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including the amortized installation cost plus operation and maintenance, is $187,518. Installation of these structural measures will result in estimated average annual benefits of $214,270, excluding those from secondary sources. The ratio of these annual benefits to the annual cost is 1.14 to 1.

The total benefits, including secondary, attributable to the structural measures are $273,670 annually. These benefits amount to an annual return of $1.40 for each dollar of cost (table 6).

PROJECT INSTALLATION

The watershed project is planned for a 5-year installation period. Land treatment measures will be established throughout the entire period by landowners and operators, in cooperation with the local soil and water conservation district. The district, with additional help from the Soil Conservation Service and the Arkansas Forestry Commission in cooperation with the U. S. Forest Service will assist with the planning and application of these measures. This assistance will be accelerated to assure application of planned measures within the project installation period. The Soil Conservation Service will provide the additional technical assistance for conservation planning, land use determination, application assistance for cropland, pastureland, rangeland, and wildlife land practices.

The Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, will provide assistance to landowners and others for determining and planning the necessary land treatment practices for forest lands. Landowners will be encouraged to apply and maintain accepted forestry measures on their woodland.

The U. S. Forest Service, by and through the Arkansas Forestry Commission, will provide the extra technical assistance necessary to accelerate the installation of forestry practices. This additional technical assistance is that planned over and above the assistance now provided to landowners under the going Cooperative Forest Management Program. A forester trained

in watershed management will be assigned to the project to guide and assist the landowners in the installation of the planned forestry measures.

The Clear Creek Soil and Water Conservation District will assume active leadership in establishing the land treatment program. The supervisors of the district by scheduled meetings and individual contacts will encourage watershed landowners and operators to establish a complete soil and water conservation program.

The Crawford County Agricultural Stabilization and Conservation Committee will cooperate with the governing body of the soil and water conservation district by selecting those Rural Environmental Assistance Program practices which will accomplish the conservation objectives in the shortest possible time.

The Agricultural Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings; preparing radio, television, and press releases; and using other methods of getting information to the watershed landowners and operators.

The sponsors will make a concerted effort to interest local landowners in establishing additional wildlife food and cover plants that will benefit quail, deer, rabbit, and dove.

Structural measures will be installed during the second, third, and fourth years of the project installation period.

The Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, and the City of Van Buren, Arkansas, have all of the necessary authority to discharge local responsibility.

The installation of the structural measures will be contingent upon the following conditions:

1. Conservation plans covering 50 percent or more of the lands in the drainage area above each detention reservoir have been developed prior to installation of structural measures.

2. All land rights have been obtained for all structural measures or a substantial part has been obtained and a written statement has been furnished by the improvement project area and the City of Van Buren, Arkansas, that the right of eminent domain will be used, if necessary, to secure the remainder within the project installation period and that sufficient funds are available for this purpose.

3. The City of Van Buren, Arkansas, is prepared to discharge its responsibilities, as set forth in this plan, for installation of Multiple Purpose Structure Number 1.

4. The Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, is prepared to discharge its responsibilities, as set forth in this plan, for installation of Floodwater Retardin Structure Number 2 and all channel improvement.

5. The project agreements have been executed.

6. The operation and maintenance agreements have been executed.

The Soil Conservation Service has been formally requested to be the contracting agency and will provide all technical assistance in design, preparation of contract payment estimates, final inspections, execution of certificates of completion, and related tasks for the establishment of planned structural measures.

FINANCING PROJECT INSTALLATION

Federal assistance will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended. This assistance is subject to the appropriation of funds.

The cost of land treatment measures will be financed by landowners and operators with assistance from federal and/or state programs. Public Law 566 funds will be provided for technical assistance to accelerate the installation of land treatment measures. Public Law 566 funds and Cooperative Forest Management Program funds will provide the technical assistance necessary to install forest land treatment measures on private forest lands.

Costs involved in the application of forest land treatment measures, other than those borne by Public Law 566 funds, will be provided by the landowners and operators. It is expected that the Rural Environmental Assistance Program will be available to qualified landowners for installing these measures. Public Law 566 funds will provide for technical assistance necessary to accelerate the installation of these measures.

The Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, has the powers under State law to secure and repay loans, assess benefits, and levy taxes and will provide the local funds needed in the installation of all structural measures except Multiple Purpose Structure Number 1. They have filed a letter of intent to borrow with the Farmers Home Administration, Little Rock, Arkansas.

Funds obtained from this loan will be used to carry out the local obligations in installing the planned structural measures. Funds for repayment of this loan will be obtained from taxes levied on the benefited area.

The City of Van Buren, Arkansas, will assume the local responsibility for the installation, operation, and maintenance of Multiple Purpose Structure Number 1. A Public Law 566 watershed loan will be obtained to finance the local share of the construction cost of this structure. The City of Van Buren owns the necessary land which will be required for Multiple Purpose Structure Number 1 at the present time. Funds for repayment of the loan will be provided by the City Park Commission from their regular source of revenues.

Public Law 566 funds will provide the construction costs and all installation costs incurred by the Soil Conservation Service in the installation of the structural measures.

PROVISIONS FOR OPERATION AND MAINTENANCE

The landowners and operators will maintain the land treatment measures under agreement with the Clear Creek Soil and Water Conservation District. The Arkansas Forestry Commission, in cooperation with the U. S. Forest Service, will furnish the technical assistance necessary for operating and maintaining the forest land treatment measures under the going Cooperative Forest Management Program. They will also continue to furnish fire protection under the Cooperative Forest Fire Control Program.

The Soil Conservation Service will provide the technical assistance necessary for the operation and maintenance of all other land treatment measures.

Representatives of the district and the Soil Conservation Service will make periodic inspections of land treatment measures and the district will encourage landowners and operators to perform needed maintenance.

Multiple Purpose Structure Number 1 will be operated and maintained by the City of Van Buren, Arkansas, at an annual cost of $300. All applicable state and local laws will be complied with in the operation of the structure.

Floodwater Retarding Structure Number 2 and all channel improvement will be operated and maintained by the Flat Rock Creek Improvement Project Area of the Clear Creek Soil and Water Conservation District, Crawford County, Arkansas, at an annual cost of $1,100. Funds for paying maintenance costs will be obtained from taxes levied on the benefited area. Maintenance will be performed with contributed labor, district-owned equipment, by contract or force account, or a combination of these methods.

Provision will be made for free access for representatives of the sponsoring local organizations and federal agencies to inspect and for the sponsors to provide maintenance for the structures at any time.

For the first three years after the structures are installed, the Soil Conservation Service and the sponsors will make a joint inspection annually, after unusually severe floods, and after the occurrence of any other unusual conditions which might adversely affect the structural measures. Inspection after the third year will be made annually by the sponsors.

All debris or obstructions that may hamper the function of the structures or channels will be removed immediately and disposed of in a proper manner.

The inspection of Multiple Purpose Structure Number 1 and Floodwater Retarding Structure Number 2 will include but not be limited to the condition of the principal spillway and its appurtenances, earth fills, emergency spillways, and fences. Annual maintenance will likely be needed to maintain an adequate vegetative cover on earth fills, vegetative emergency spillways, and borrow areas. During the life of the structure, it may be necessary to do major repair work to restore concrete that has deteriorated; replace gates, trash racks, or other metal works; remove and/or stabilize slide material, and replace eroded material and revegetate the emergency spillways. Fences will be maintained until there is mutual agreement that they are no longer needed to protect structural works of improvement.

The inspection of the channels, with appurtenances, will be made to determine the need for vegetation control, bank stabilization, or other obstacles which could result in an abnormal reduction in channel capacities. Special attention will be given to the inspection and maintenance of the grade stabilization structures. Annual maintenance may be required to remove debris and to control and maintain proper vegetation. During the life of the channels, it may be necessary to remove silt bars, replace grade stabilization structures, and fill contraction cracks in the concrete-lined channel.

The access roads along the channels will also be maintained for inspection and maintenance of the channels.

The sponsoring local organizations will maintain a record of all maintenance inspections and maintenance performed and have the record available for review by the Soil Conservation Service. They fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of invitations to bid on the construction of the structural measures.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Flat Rock Creek Watershed, Arkansas

Installation Cost Item	Unit	Number to be Applied	Estimated Cost (Dollars) 1/ P. L. 566 Funds	Other Funds	Total
LAND TREATMENT MEASURES					
Soil Conservation Service					
Cropland	Acre	3,000	-	60,375	60,375
Grassland	Acre	3,500	-	48,300	48,300
Wildlife	Acre	880	-	8,225	8,225
Technical Assistance			5,000	4,200	9,200
Soil Survey	Acre	19,000	2,500	2,500	5,000
SCS Subtotal			7,500	123,600	131,100
Forest Service					
Forest Land	Acre	3,100	-	87,100	87,100
Cooperative Forest Fire Control	Acre	4,270	9,700	5,200 2/	14,900
Technical Assistance			12,500	3,560 3/	16,060
FS Subtotal			22,200	95,860	118,060
TOTAL LAND TREATMENT MEASURES			29,700	219,460	249,160
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Multiple Purpose Structure Number 1	Number	1	180,241	40,009	220,250
Floodwater Retarding Structure Number 2	Number	1	340,000	-	340,000
Channel Improvement	Mile	7.4	1,907,901	-	1,907,901
Subtotal - Construction			2,428,142	40,009	2,468,151
Engineering					
Soil Conservation Service			219,857	-	219,857
Subtotal - Engineering			219,857	-	219,857
Relocation Payment					
Soil Conservation Service	Number	2	3,000	-	3,000
Subtotal - Relocation Payment			3,000	-	3,000
Project Administration					
Soil Conservation Service					
Construction Inspection			219,858	-	219,858
Administrative Cost			241,843	10,993	252,836
Advisory Assistance Service			-	406	406
Subtotal - Project Administration			461,701	11,399	473,100
Other Cost					
Land Rights			-	443,550	443,550
Subtotal - Other			-	443,550	443,550
TOTAL STRUCTURAL MEASURES			3,112,700	494,958	3,607,658
TOTAL PROJECT			3,142,400	714,418	3,856,818
SUMMARY					
Subtotal SCS			3,120,200	618,558	3,738,758
Subtotal FS			22,200	95,860	118,060
TOTAL PROJECT			3,142,400	714,418	3,856,818

1/ Price Base: 1970.
2/ Includes $1,800 capital outlay acceleration based on 1965 Area and Cost Review.
3/ Includes $60 from the going Cooperative Forest Management Program.

May 1970

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of work plan preparation)

Flat Rock Creek Watershed, Arkansas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT MEASURES			
Conservation Cropping System	Acre	1,600	24,000
Crop Residue Management	Acre	1,600	4,000
Brush Control	Acre	1,600	4,800
Pasture and Hayland Planting	Acre	2,600	78,000
Pasture and Hayland Management	Acre	1,800	3,600
Pasture Proper Grazing Use	Acre	750	1,500
Cooperative Forest Fire Control Program	Acre	4,270	4,270
Wildlife Habitat Management	Acre	30	225
STRUCTURAL MEASURES			
Diversion	Foot	10,000	500
Farm Pond	Number	100	30,000
Land Smoothing	Acre	100	1,500
Drainage Main or Lateral	Foot	26,000	10,400
Drainage Field Ditch	Foot	13,000	650
Terrace Gradient	Foot	5,000	250
TOTAL		XXXXXX	163,695

1/ Price Base: 1970.

May 1970

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Item	Installation Cost P. L. 566 Funds				Installation Cost Other Funds				Total Installation Cost
	Construction	Engineering Services	Relocation Payments	Total P. L. 566	Construction	Engineering Services	Land Rights	Total Other	
Multiple Purpose Structure Number 1	180,241	19,152	-	199,393	40,009	-	39,200	79,209 4/	278,602
Floodwater Retarding Structure Number 2	340,000	30,357	3,000	373,357	-	-	131,800	131,800 5/	505,157
Channel Number 1	1,894,797	169,178	-	2,063,975	-	-	264,350	264,350 2/	2,328,325
Channel Number 2	13,104	1,170	-	14,274	-	-	8,200	8,200 3/	22,474
Subtotal - Channels	1,907,901	170,348	-	2,078,249	-	-	272,550	272,550	2,350,799
Subtotal - Channels and Structures	2,428,142	219,857	3,000	2,650,999	40,009	-	443,550	483,559	3,134,558
Project Administration	XXXXXXXXX	XXXXXXX	XXXXX	461,701	XXXXXX	XXX	XXXXXXX	11,399	473,100
TOTAL PROJECT	2,428,142	219,857	3,000	3,112,700	40,009	-	443,550	494,958	3,607,658

1/ Price Base: 1970.
2/ Includes $140,000 for reconstruction and modification of two structures under Missouri-Pacific Railroad, $3,000 for relocation of sewer lines, $700 for relocation of power lines, $500 for relocation of water lines, $750 for relocation of gas lines, $8,000 for two buildings, $28,000 for fencing, and $70,400 for road and bridge cost.
3/ Includes $8,000 for the installation of one bridge.
4/ Includes $17,400 for relocation of sewer line.
5/ Includes $9,500 for relocation of power lines and $15,000 for one building.

May 1970

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Item	COST ALLOCATION PURPOSE			COST SHARING Public Law 566			COST SHARING Other		
	Flood Prevention	Water Resource Improvement for Recreation	Total	Flood Prevention	Water Resource Improvement for Recreation	Total	Flood Prevention	Water Resource Improvement for Recreation	Total
Multiple Purpose Structure Number 1	177,386	101,216	278,602	152,427	46,966	199,393	24,959	54,250	79,209
Floodwater Retarding Structure Number 2	505,157	-	505,157	373,357	-	373,357	131,800	-	131,800
Channel Improvement	2,350,799	-	2,350,799	2,078,249	-	2,078,249	272,550	-	272,550
GRAND TOTAL	3,033,342	101,216	3,134,558	2,604,033	46,966	2,650,999	429,309	54,250	483,559

1/ Price Base: 1970.

May 1970

TABLE 3 - STRUCTURE DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY

Flat Rock Creek Watershed, Arkansas

Item	Unit	Structures Numbers: 1	2	Total
Class of Structure		c	c	XXXXXXX
Drainage Area	Sq. Mi.	0.36	5.17	5.53
Curve No. (1-day)(AMC II)		80	74	XXXXXXX
Tc	Hrs.	0.46	1.5	XXXXXXX
Elevation Top of Dam	Ft.	542.7	512.7	XXXXXXX
Elevation Crest Emergency Spillway	Ft.	537.7	504.5	XXXXXXX
Elevation Crest High Stage Inlet	Ft.	535.7	494.1	XXXXXXX
Elevation Crest Low Stage Inlet	Ft.	527.8	481.5	XXXXXXX
Elevation Crest Mitigation Inlet	Ft.	-	477.8	XXXXXXX
Maximum Height of Dam	Ft.	57	57	XXXXXXX
Volume of Fill	Cu. Yd.	115,210	298,230	413,440
Total Capacity	Ac. Ft.	300	2,001	2,301
Sediment Submerged 1st 50 years	Ac. Ft.	19	102	121
Sediment Submerged 2nd 50 years	Ac. Ft.	18 1/	94	112
Sediment Aerated	Ac. Ft.	2	14	16
Water Resource Improvement for Recreation	Ac. Ft.	109	-	109
Retarding	Ac. Ft.	152	1,791	1,943
Between High and Low Stage	Ac. Ft.	115	255	XXXXXXX
Surface Area				
Sediment Pool	Acre	3	31	34
Water Resource Improvement for Recreation	Acre	11	-	11
Retarding Pool	Acre	20	145	165
Principal Spillway				
Rainfall Volume (areal)(1-day)	In.	9.1	9.1	XXXXXXX
Rainfall Volume (areal)(10-day)	In.	16.3	16.3	XXXXXXX
Runoff Volume (10-day)	In.	11.2	9.8	XXXXXXX
Capacity of Low Stage (Maximum)	cfs	26	67	XXXXXXX
Capacity of High Stage (Maximum)	cfs	123	180	XXXXXXX
Frequency Operation - Emergency Spillway	% chance	1	1	XXXXXXX
Size of Conduit	Dim.	30	36	XXXXXXX
Emergency Spillway				
Rainfall Volume (ESH)(areal)	In.	12.5	12.5	XXXXXXX
Runoff Volume	In.	9.9	9.1	XXXXXXX
Type		Veg.	Veg.	XXXXXXX
Bottom Width	Ft.	50	350	XXXXXXX
Velocity of Flow (Ve)	Ft./Sec.	1.42	7.28	XXXXXXX
Slope of Exit Channel	Ft./Ft.	.022	.028	XXXXXXX
Maximum Water Surface Elevation	Ft.	538.0	506.9	XXXXXXX
Freeboard				
Rainfall Volume (FH)(areal)	In.	30.0	30.0	XXXXXXX
Runoff Volume (FH)	In.	27.2	26.2	XXXXXXX
Maximum Water Surface Elevation	Ft.	542.7	512.7	XXXXXXX
Capacity Equivalents				
Sediment Volume	In.	2.04	0.76	XXXXXXX
Retarding Volume	In.	8.00	6.48	XXXXXXX

1/ Second 50 years sediment is submerged in recreation pool for the project life.

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TABLE 3A - STRUCTURE DATA - CHANNELS

Flat Rock Creek Watershed, Arkansas

Channel Number	Station	Drainage Area (sq. mi.)	Capacity cfs: Required	Capacity cfs: Design	Water Surface Elevation (ft. MSL)	Channel Dimensions: Hydraulic Gradient (ft./ft.)	Channel Dimensions: Bottom (ft.)	Channel Dimensions: Depth (ft.)	Channel Dimensions: Side Slopes	Channel Dimensions: Cross Sectional Area (sq. ft.)	Channel Dimensions: Wetted Perimeter (ft.)	"n" Value: Aged	"n" Value: As Built	Velocities: Aged	Velocities: As Built	Type of Improvement 1/
1 4/	70+00	0.99	949	949	417.8	.0010	20	5.3	Vert.	-	-	.012	.012	8.95	8.95	L
	82+25	1.01	949	949	416.3	.0010	20	5.3	Vert.	-	-	.012	.012	8.95	8.95	L
	93+00	1.01	1,265	1,265	405.8	.0011	22	5.8	Vert.	-	-	.012	.012	9.91	9.91	L
	112+00	1.52	1,416	1,416	402.0	.0010	22	6.4	Vert.	-	-	.012	.012	10.05	10.05	L
	122+00	1.53	1,416	1,416	401.9	.00054	24	7.4	Vert.	-	-	.012	.012	7.97	7.97	L
	132+40	1.99	1,526	1,526	401.8	.00036	26	8.4	Vert.	-	-	.012	.012	6.98	6.98	L
	136+50	2.18	1,526	1,526	401.6	.00030	28	8.4	Vert.	-	-	.012	.012	6.48	6.48	L
	149+50	2.69	1,526	1,526	401.4	.00025	30	8.4	Vert.	-	-	.012	.012	6.05	6.05	L
	161+00	2.69	1,526	1,526	399.6	.00025	30	8.4	Vert.	-	-	.012	.012	6.05	6.05	L
	236+91	3.18	1,056	1,150	398.7	.0001	60	8.0	3:1	-	-	.030	.025	1.65	1.98	CE
	292+41	3.62	1,122 2/	1,122 3/	-	-	-	-	-	-	-	-	-	-	-	C & S
2	203+16	15.11	740	1,360	402.3	.0034	-	-	-	159	64	.035	.035	4.65	4.65	C & S
	257+16	15.60	780	1,513	392.9	.0014	-	-	-	184	42	.035	.035	4.24	4.24	C & S
	293+83	17.00	850	850	389.6	.0002	-	-	-	380	56	.035	.035	2.23	2.23	C & S
	328+83	19.15	976	958	388.9	.0005	-	-	-	321	57	.035	.035	3.05	3.05	C & S
	353+50	19.84	1,011	1,448	387.4	.0009	-	-	-	274	56	.035	.035	3.68	3.68	C & S
	373+50	20.12	1,046 5/	3,400	386.3	.0002	-	-	-	388	68	.035	.035	2.70	2.70	C & S

1/ C & S - clearing and snagging; CE - channel enlargement; and L - lined channel.
2/ Design capacity provides 100-year protection.
3/ IBM-650 water surface profile data shows that the channel below 236+91 is adequate with incidental debris removal.
4/ Total excavation = 135,794 cubic yards.
5/ Design capacity is the 1-year routed peak discharge.

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TABLE 3B - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES 1/

Flat Rock Creek Watershed, Arkansas

Station Number	Design Capacity (c.f.s.)	Drop (feet)	Width (feet)	Slope
70+00	949	3.4	20	10:1
84+90	1,265	4.2	30	3:1
96+25	1,416	6.3	22	10:1

1/ Structures will be similar to SAF chute-type structures.

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TABLE 4 - ANNUAL COST

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Town Branch			
Multiple Purpose Structure Number 1 and Channel Number 1	134,491	800	135,291
Project Administration	20,889	XXX	20,889
Subtotal	155,380	800	156,180
Flat Rock Creek			
Floodwater Retarding Structure Number 2 and Channel Number 2	27,220	600	27,820
Project Administration	3,518	XXX	3,518
Subtotal	30,738	600	31,338
GRAND TOTAL	186,118	1,400	187,518

1/ Price Base: Installation, 1970; O&M, adjusted normalized.
2/ 100 years @ 5.125 percent interest.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Flat Rock Creek Watershed, Arkansas

(Dollars)

Item	Estimated Average Annual Damage		
	Without Project	With Project	Reduction
Floodwater			
Crop and Pasture	17,280	4,530	12,750
Other Agricultural	250	70	180
Nonagricultural			
Residential	83,943	48	83,895
Commercial	4,557	0	4,557
Industrial	16,220	32	16,188
Subtotal	122,250	4,680	117,570
Indirect	18,820	830	17,990
TOTAL	141,070	5,510	135,560

1/ Price Base: Adjusted normalized.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Flat Rock Creek Watershed, Arkansas

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS								Average Annual Cost 3/	Benefit-Cost Ratio
	Flood Prevention				Nonagricultural Water Management					
	Damage Reduction	Intensified Land Use	Changed Land Use: Agricultural	Changed Land Use: Urban	Recreation	Secondary	Redevelopment	Total		
Town Branch										
Multiple Purpose Structure Number 1 and Channel Number 1	123,770	450	1,230	19,900	10,350	36,300	14,770	206,770	135,291	1.5 to 1
Project Administration	XXXXXXX	XXX	XXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXXX	20,889	XXXXXXXX
Subtotal	123,770	450	1,230	19,900	10,350	36,300	14,770	206,770	156,180	1.3 to 1
Flat Rock Creek										
Floodwater Retarding Structure Number 2 and Channel Number 2	10,440	3,450	3,330	20,800	-	23,100	5,780	66,900	27,820	2.4 to 1
Project Administration	XXXXXX	XXXXX	XXXXX	XXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXXX	3,518	XXXXXXXX
Subtotal	10,440	3,450	3,330	20,800	-	23,100	5,780	66,900	31,338	2.1 to 1
GRAND TOTAL	134,210 2/	3,900	4,560	40,700	10,350	59,400	20,550	273,670	187,518	1.4 to 1

1/ Price Base: Adjusted normalized prices.
2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $1,350 annually.
3/ From table 4.

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INVESTIGATIONS AND ANALYSES

Land Treatment

The Conservation Needs Inventory for Crawford County provided information on land use by soil capability units. Information was also obtained from the work unit and area offices concerning soils, capability units, and land use in the watershed. This information was used to develop the conservation needs for the watershed.

The quantity and cost of land treatment measures already applied were determined from field inspections, interviews with farm operators, and work unit records and personnel. This information was utilized in preparing table 1A.

A systematic field survey showed ground cover, forest and hydrologic conditions, and treatment needs. This survey, supporting data, and information from other agencies and forestry officials served as a basis for the amount of remedial measures. The measures recommended will contribute to flood reduction and soil stabilization.

The conservation measures to be applied during the project installation period were determined on the basis of the need for treatment for watershed protection and flood prevention and the level of participation expected from landowners and operators. Consideration was also given to anticipated land use changes in the future, personnel available for technical assistance and planning, funds available for cost sharing from the Agricultural Stabilization and Conservation Service, the ability of local landowners and operators to provide their share of funds, and experience gained from other projects.

Engineering

A base map of the watershed was prepared to show the watershed boundary, drainage pattern, system of roads, and other pertinent information.

Vertical controls were established from U. S. Coast and Geodetic Survey bench marks in the watershed and all surveys were referenced to mean sea level elevations.

Topographic information on the two sites was obtained by use of a telescopic alidade and a plane table. Maps with 4-foot contour intervals were prepared. Stage-storage and stage-surface area curves were developed using this information.

The heights of the dams and the sizes of the pools were determined by the storage volumes needed to contain the runoff from the design storm and to provide an additional storage for sediment. The principal spillways were determined by using the minimum pipe diameters

recommended for Class "c" structures. The emergency spillways were determined by flood routing the emergency spillway and freeboard storms. Sufficient detention storage is available to permit the use of vegetative emergency spillways.

The designs of the structures were based on procedures and criteria set out in Engineering Memorandum SCS-27 (Rev.) - "Earth Dams." In addition to the valley sections, additional channel cross sections were surveyed in the highly developed areas. Bridge and culvert cross sections were also taken.

Channel designs were based on procedures and criteria set out in Technical Release Number 25, Planning and Design of Open Channels. Channel Number 1 was designed to accommodate the flow from the 100-year peak discharge. Channel Number 2 was designed to accommodate the flow from the approximate 1-year peak discharge.

The lined channel was designed with the velocities in the subcritical range (S_o less than 0.7 S_c). This was accomplished by utilizing three grade control structures similar to SAF chute-type structures.

The design of the lined channel from Station 161+00 to 96+14 was based on procedures and criteria set out in SCS Technical Release Number 15 with the associated ES charts. The Fort Worth Engineering and Watershed Planning Unit made a model study and prepared the preliminary design for the remainder of the lined channel. This complex section includes expanding the bottom width to connect to multi-box culverts under U. S. Highway Number 64, determining the design hydraulics and capacity under a washateria that is connected to the highway structure, and grade control structure below the washateria.

A closed conduit was planned across the parking lot immediately above U. S. Highway Number 64.

The designed channel velocities of the earth channels which require improvement are considerably less than the velocities being experienced by some of the existing stable channels within the watershed.

Land rights maps showing the area needed for development were prepared for the sponsoring organizations.

A summary of physical data is shown in tables 3 and 3A.

Hydraulic and Hydrologic

Basic Data Available

Rainfall records at Fort Smith, Arkansas, are available for the period of 1878 to the present. Runoff can be related to a gage on Cove Creek near Lee Creek, Arkansas

Aerial photographs, watershed base maps, and quadrangle maps provided basic topographic information. Thirty-one valley sections showing

topography, land use, and other pertinent data were surveyed to provide data for streamflow computations. Elevations were determined for all homes and businesses along Town Branch that were expected to flood.

Land use and cover conditions on agricultural land for both present and future conditions were estimated with the help of the district conservationist. Cover conditions on all woodland were determined by the U. S. Forest Service.

Soil cover complex which takes into consideration factors such as soils, relief, land use, and cover conditions were assembled in order to compute runoff curve numbers. These curve numbers were used in computing runoff for both present and with the land treatment measures installed.

Project Evaluation

Stage-discharge and stage-area inundated relationships were computed, as programmed on the IBM-650 computer. The computer uses the Doubt Method for backwater computations and valley width with reach length for area inundated computations. Water surface profiles through the bridges were computed using the contracted opening procedure similar to the method used by the Bureau of Public Roads and the U. S. Geological Survey. Water surface profile data for the lined channel were developed using the procedure in SCS Technical Release Number 15 with the associated ES charts. A model study was performed on a complex segment by the Fort Worth Engineering and Watershed Planning Unit.

Evaluation routings were made by a frequency method. Rainfall volumes of seven frequencies were taken from U. S. Weather Bureau Technical Paper 40 and two less than annual frequencies were determined from Technical Paper 40 data logarithmically extrapolated. Runoff volumes were determined by using runoff curve numbers. The Flat Rock Creek Unit was routed with present and three alternatives of structural measures. The Town Branch Unit was routed with present and two alternatives of structural measures. The stream reach routings were performed on the IBM-360 computer. The computer uses the coefficient routing method and the hydrographs were developed incrementally from a dimensionless hydrograph and a SCS one-day watershed evaluation storm cumulative rainfall table type 1.

Area flooded was determined for each of the nine storms routed for each alternate. Depth of flooding in each of the homes and businesses in Van Buren were also determined for each storm for each alternate.

The water surface profile data was changed to allow for the effect of the channel improvement by modifying the computer output.

Structure Data

Both structures are equipped with two-stage risers. Structure Number 1 has a 70-csm first stage with a 340-csm second stage set at the 100-year frequency. The first stage was determined by the available channel capacity downstream from the structure and the second stage was

determined by full pipe flow. Structure Number 2 has an approximate 15-csm first stage with the second stage near 35 csm set at the 5-year frequency. These release rates allow for an approximate 10-day emptying time or less.

Floodwater detention storage was determined by routing principal spillway hydrographs. Rainfalls were taken from U. S. Weather Bureau Technical Papers 40 and 49. Routings were made as programmed on the IBM-1130 computer and were performed in accordance with criteria set out in Engineering Memorandum SCS-27.

Emergency spillway and freeboard hydrographs were computed and routed as programmed on the IBM-1130 computer which uses procedures outlined in Section 4 of the SCS National Engineering Handbook. The rainfall volumes were determined from maps included in Chapter 21 of Section 4 of the SCS National Engineering Handbook.

An orifice to discharge approximately .02 csm will be located in the riser of Structure Number 2 at the elevation of 477.8 feet mean sea level. The flow from this orifice will mitigate any depletion of streamflow by reservoir evaporation and seepage. The storage volume set aside for the second fifty years of sediment will be used to provide the supply for this orifice. The orifice will be located at the elevation of the first fifty years of sediment and the first stage will be located at the 100-year sediment elevation. The storage set aside will be adequate except during periods of extreme drought.

The design channel capacity for Town Branch was determined by routing the 100-year frequency peak discharge. The post project capacity of Flat Rock Creek is near the 1-year frequency peak discharge. Floodwater Retarding Structure Number 2 did not alone provide an acceptable level of protection making channel improvement necessary. Channel excavation would cause serious damage to the fish and wildlife habitat and channel erosion was possible. Channel clearing will significantly reduce the existing roughness and an acceptable level of protection can be reached without damaging the wildlife habitat or creating an erosive condition.

Geologic

Structures

A preliminary geologic investigation was made on both proposed damsites. This included studies of stratigraphy, rock structure, borrow materials, and depths of overburden at the sites. These investigations were implemented by the use of portable seismic equipment.

Bedrock beneath Structure Numbers 1 and 2 is sandstone and shale of the Hartshorne formation. Both damsites, which are underlain by competent bedrock at shallow depths, appear to have sufficient foundation strength for the proposed embankments.

The geologic structure of the area includes several anticlinal and synclinal folds in addition to the Mulberry Fault which traverses the central

portion of the watershed in a northeast-southwest direction. Both dam sites are situated north of the fault trace where several hundred feet of vertical displacement has occurred. The fault is now dormant and should present no stability problems for the proposed embankments.

The emergency spillway of Structure Number 1 will contain a moderate amount of sandstone which will classify as rock excavation. This sandstone can be utilized in a rock toe in the downstream portion of the embankment. The emergency spillway of Structure Number 2 is not expected to contain any rock excavation.

Borrow materials occur in alluvial deposits. They are mostly GC and CL materials. Structure Number 1 will require approximately 11 acres of off-site borrow and Structure Number 2 will need about 18 acres of off-site material for the embankment.

Natural resources in the Flat Rock Creek Watershed include deposits of sandstone, shale, gravel, sand, and natural gas. Large quantities of sandstone are found within the boundaries of the watershed and one large sandstone quarry is located in the north-central portion of the watershed. With reference to the above quarry, Bulletin 645, Mineral Resources and Industries of Arkansas, U. S. Department of the Interior, Bureau of Mines, 1969, states:

> Sandstone north of Van Buren in the SE¼ SE¼ of Section 8, Township 9 North, Range 31 West, has been quarried for about ten years. Two beds in the Hartshorne sandstone are utilized. The upper bed, averaging 12 feet thick, is a source of crushed stone for highway construction. A more resistant lower bed, 50 to 15 feet thick, is used for concrete aggregate and road-surfacing material. Sandstone production has been about 4.7 million tons and sandstone reserves are at least equal to total past production.

Mining of shale for roadstone is limited to small, isolated areas in the watershed. Extensive sand and gravel deposits occur in the bed of the Arkansas River near the mouth of Flat Rock Creek Watershed, but mining of sand and gravel in the watershed will be limited to small, isolated deposits along Flat Rock Creek and its tributaries. Large quantities of natural gas reserves exist in the watershed. The nearest known producing gas wells to any planned structural measures are more than 2.5 miles from such structural measures and continued extraction from these wells is not expected to adversely affect the foundations of the structural measures. There are no known existing dry holes, mine openings, or other known pollution sources within the pool areas or drainage areas of Structure Numbers 1 and 2.

Water quality in the proposed reservoirs is expected to be good. The drainage areas of the reservoirs have fair to good vegetative cover, the land use being predominantly woodland and pasture-range.

Channels

Studies of the earth channel sections indicate that stability from the standpoint of runoff flow will not be a problem. Both channels contain no appreciable bedload. Bedrock will not be encountered in any of the planned excavation. Channel bank and bottom materials on Channel Number 1 were sampled at thirteen locations and analyzed for size distribution and plasticity. The materials are nonplastic to slightly plastic with plasticity indexes ranging from 0 to 8, D_{75} sizes range from 0.175 mm to 0.54 mm. Of the thirteen samples, two are classified as ML, seven are SM, and four are SP.

Based on the permissible velocities procedure in Technical Release 25, the lowest computed allowable velocity of 1.9 feet per second will not be exceeded.

A changed condition in the ground water table could present a stability problem during the construction of Channel Number 1. The problem is created by the elevated water table created by Lock and Dam 13 on the Arkansas River. Preliminary studies, investigations, and information supplied by the Corps of Engineers and U. S. Geological Survey indicate that the water table will be slightly above the elevation of the bottom of Channel Number 1. An estimate of the rate of return flow into the channel is 15 cfs. This volume of water is not significant but the SM and SP material which would have to be excavated will be completely saturated resulting in a possible bank stability problem. Therefore, the depth of excavation on Channel Number 1 will be limited to elevation 392.0 feet mean sea level to minimize seepage from the Arkansas River. This revised design would allow the phreatic line of the water table to slope downward as it approached the channel and would intersect the channel at grade. Stability is not expected to be a problem once vegetation on the banks is established.

Sedimentation

Sediment sources were located and evaluated by field mapping methods. Soil cover complex and erosion studies were conducted on a representative portion of the upland area of the watershed. The basic erosion rate for each land use was determined from the detailed investigation. The present and future projected erosion and sedimentation rates were computed for Sites 1 and 2. Delivery ratios of damaging sediment from sheet erosion losses to the reservoirs are estimated to be 60 percent for Site 1 and 42 percent for Site 2. It is expected that the sediment yield from the watershed uplands will be reduced by 42 percent by land treatment and structural measures.

Watershed analyses indicate that average annual suspended sediment concentration will be reduced by 45 percent by land treatment and structural measures. This will result in a reduction of 203 parts per million from approximately 454 parts per million under present conditions to 251 parts per million for future conditions.

Hollis Lake which is located near the watershed outlet is currently receiving sediment at an annual rate of 7.29 acre-feet. At this rate,

the lake will be depleted by the year 2025. With the installation of planned land treatment and structural measures, Hollis Lake is expected to receive 41.58 acre-feet of sediment during a 5-year installation period, and an annual amount of 4.04 acre-feet thereafter. Although the annual sedimentation rate will be increased during the installation period by channel construction, the decreased sedimentation during the remaining period will substantially reduce the total sediment accumulation. This reduction will prolong the life of Hollis Lake by approximately 39 years.

Economic

The benefited area was divided into two separate evaluation units which contained a total of five evaluation reaches for purposes of the economic analysis. These divisions were made because of the diversity of damageable values and the variation in physical characteristics of the flood plain. Reach 1 is the agricultural flood plain of Town Branch and Reach 2 is the urban area of Van Buren that is in the Town Branch flood plain. Reaches 3, 4, and 5 include the benefited area of Flat Rock Creek which is predominantly agricultural. The reach locations are shown on the project map.

Damage schedules were obtained from the landowners and operators of about 30 percent of the agricultural flood plain in the watershed. The sample area was considered sufficient and representative for the evaluation. These schedules provided historical information on flooding and flood damages as well as land use, rotation patterns, crop yields, production costs, and probable changes in land use. Land use and crop yield projections, as related to land resource areas and soil capability units, were obtained from river basin studies made by the Economic Research Service. These projections and the information in the field schedules were used to determine future "without project" conditions. The land use and yields in the watershed are actually present today or are based on the ERS projections for soils that are similar to those in the flood plain.

The frequency method was used throughout the analysis. Floodwater damages were computed for future "without project" conditions and future "with project" conditions. The difference in average annual damages before project installation and the damages remaining after project installation constitutes the damage reduction benefits.

Crop and pasture damages were evaluated as follows. The land use, yield, and adjusted normalized prices were used to determine the damageable value per composite flood-plain acre. The damage rate per acre by depth increments and season of the year were obtained from factors that express damage for the respective depths and seasons as a percent of the value. The seasonal distribution of flooding was based on an analysis of historical rainfall records for Fort Smith, Arkansas, and the damages for selected frequency storms were computed from the acres flooded by depth increments and the corresponding damage per acre. The crop and pasture damages were converted to average annual equivalents and adjusted for recurrent flooding. The benefits from the reduction of crop and pasture damages included two effects: (1) reduction in area flooded, and

(2) reduction in depth of flooding.

Crop and pasture damages were adjusted downward on the portion of the flood plain that will have a 100-year level of protection. This adjustment was made to account for the crop and pasture damages and benefits that will not be realized due to rapid industrial development that is anticipated on this area following project installation.

Damage to other agricultural property, such as fences and livestock, was estimated for Reaches 4 and 5. This estimate was based on damage rates per acre used in the upper reaches of the Little Mulberry Creek Watershed which is located closeby and possesses physical characteristics that are very similar to this watershed. Other agricultural damages are insignificant in Reaches 1, 2, and 3 and were not analyzed.

Nonagricultural damages in the watershed consist of urban damages in the City of Van Buren caused by flooding from Town Branch. A detailed survey provided the location and elevation of each property within the 100-year flood zone. The value of each property was estimated for use in evaluating the damages. Interviews with the owners and occupants provided information on experienced floods, high water marks, and the damages which resulted. Damages were based on the depth of flooding and were calculated for several frequency storms.

The average annual urban damages were computed for the present state of development. It is estimated that normal improvements to the existing facilities, new development, and the increase in price and quantity of furnishings over time will result in higher values and damages in the future. The urban damages were adjusted upward based on projections of per capita income for Economic Area 08113, Ft. Smith, Arkansas, made by the Office of Business Economics, U. S. Department of Commerce. These incomes were treated as an increasing annuity for forty years and as a constant annuity thereafter. A factor which expressed the present net effect of the income increase was applied to the "without project" and "with project" damage to reflect the gradual accrual of these values over time.

Benefits from the reduction of indirect damages were based on the direct damage reduction benefits. Indirect damages were estimated to be 15 percent of the urban damage and 10 percent of all other kinds of direct damage.

A portion of the damage reduction benefits were assigned to the land treatment measures included in the project. These benefits which amount to 1 percent of the total damage reduction benefits were not used for project justification.

Enhancement type benefits expected to result from project installation were evaluated. The land use and crop yields, as projected by the Economic Research Service, and other available information indicate that changed and more intensive land use will occur on portions of the flood plain following project installation. The changed and intensified land use benefits represent the difference in net profits from farming

operations between future "without project" and future "with project" conditions. The associated costs were deducted and the increased damage to higher values was subtracted to arrive at the net benefit. The benefits were discounted for the appropriate lag in accrual.

Recreation benefits will accrue from the use of Multiple Purpose Structure Number 1. These benefits were based on a value of $1.00 for a visitor-day of use and an estimated 10,350 days of use annually. The visitor-days of use were estimated from secondary data and from field surveys in the local area. Factors that were considered in determining the visitor-days of use include the present population and trend, the area and facilities available for use, competitive recreational developments in the area, accessibility and convenience of the site, the capacity for sustained use, and the opportunities for different types of recreational use by seasons.

Redevelopment benefits will also accrue from the project as a result of providing employment opportunities for local labor in the construction and operation and maintenance of the project. The redevelopment benefits were based on 10 percent of the construction cost being expended for local labor. The redevelopment benefits from operation and maintenance of the project and from the basic labor required in the industrial development stimulated by the project were treated as a decreasing annuity for twenty years and appropriately discounted to obtain the present net worth.

Secondary benefits were analyzed to determine the effect of increased income and employment generated by the project. These benefits will be realized by landowners, workers, processors, and business establishments in the trade area. In the analysis, consideration was given to values added to several sectors of the local economy, as measured by economic multipliers.

The investment multiplier was used to measure the effects of (1) values added to agricultural inputs, (2) values added to transportation, processing and marketing, (3) values added to local retailers, and (4) the values added by additional employment. The values added to agricultural inputs were considered to be the difference in the farmer's cost for additional inputs and the wholesale value of those inputs. The values added to transportation, processing, and marketing were considered to be the difference in the value of the product as it leaves the local area and its value at the farm. The values added to local retailers are the amounts available for successive rounds of consumption spending.

The employment multiplier was used to measure the total effect of creating additional employment. The primary effect was treated as a redevelopment benefit, and the difference between the total and primary effect was considered to be a secondary benefit.

The employment multiplier was derived from the occupational classifications of the employed labor force. The ratio of the total employment to those employed in basic occupations was used as a basis for estimating the multiplier. The basic occupations included agriculture, forestry

fisheries, mining, manufacturing, and construction, exclusive of the construction employment used to determine redevelopment benefits. The basic data for estimating the employment multiplier were obtained from U. S. Census of Population, Arkansas, 1960, General Social and Economic Characteristics, table 85.

The investment multiplier was based on data in the USDA Consumer Expenditure Survey Report No. 3, "Consumer Expenditures and Income, Rural Farm Population, Southern Region, 1961." The multiplier was estimated by summing the effects of successive rounds of spending and respending. The consumption expenditure for each of the successive rounds of spending and respending was based on the farm families' marginal propensity to consume.

The investment multiplier times the various sources of new income yields the total effect of the successive rounds of spending this new income. To estimate the net local effect of the project-induced investments and employment, both multipliers were adjusted to account for leakages. According to Wadsworth and Conrad, in a study of labor-surplus rural areas, it was concluded that because of leakage, only 12 percent of the newly created investment would be a local benefit. Hence, the investment multiplier was adjusted downward by 88 percent to account for nonlocal effects. The employment multiplier was adjusted to account for unused capacity. It was assumed for this analysis that labor would function at 90-percent efficiency.

The installation cost of the structural measures was converted to average annual equivalents by amortization for 100 years at 5.125 percent interest. Annual operation and maintenance costs were estimated and added to the annual installation cost to arrive at the total annual cost.

Areas that will be inundated by the flood pools were excluded from the damage appraisal. Production to be lost in these areas after installation of the project was compared with the appraised value of the sites. In this analysis, it was considered that there would be no production in the permanent pools. It was assumed that the land inundated by the flood pool would remain in the present use, woodland and grassland, under project conditions. The appraised value of the easement exceeded the value of production lost and the appraised value of the easement was used in project cost. The values used for land, easements, and rights-of-way were arrived at by using the market data approach.

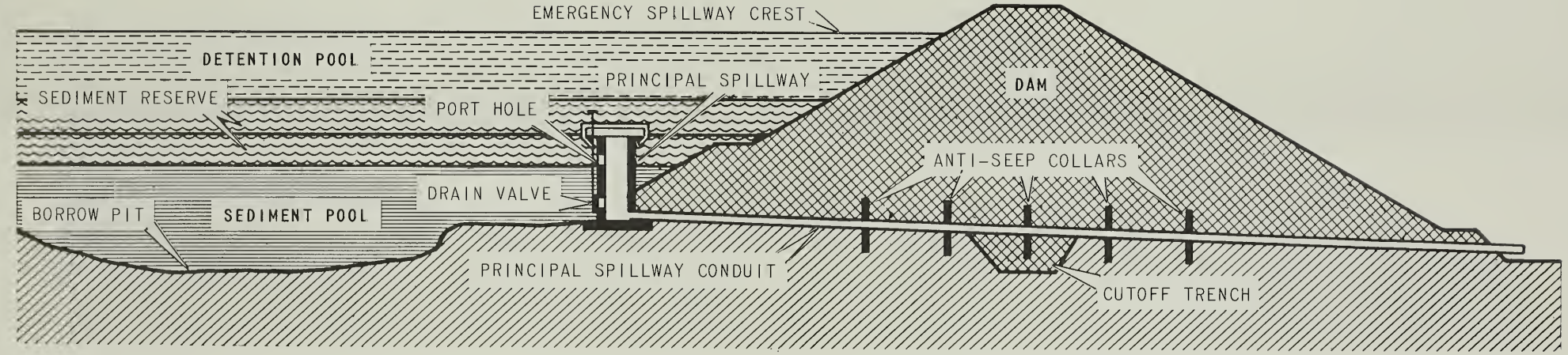


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

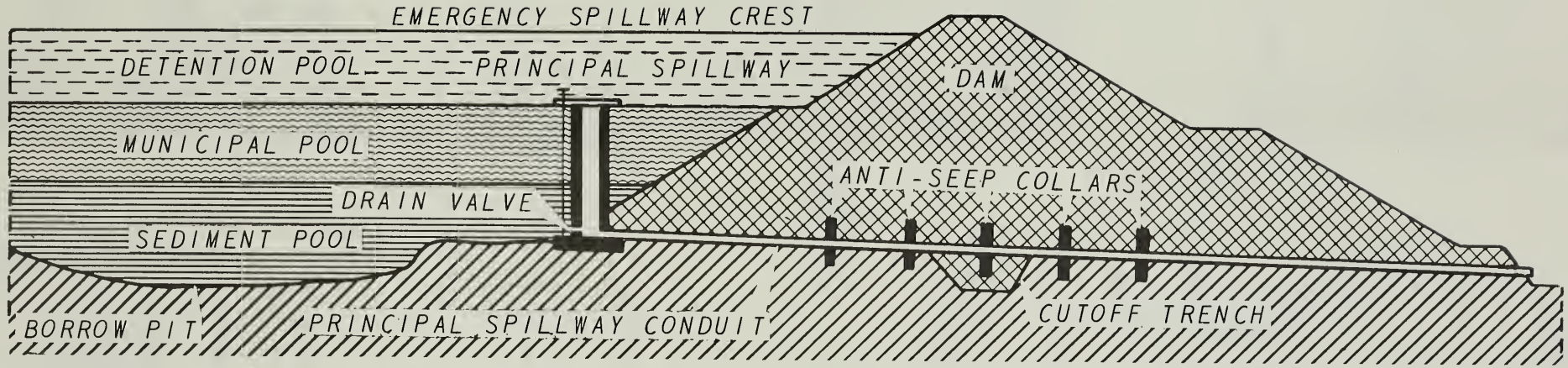
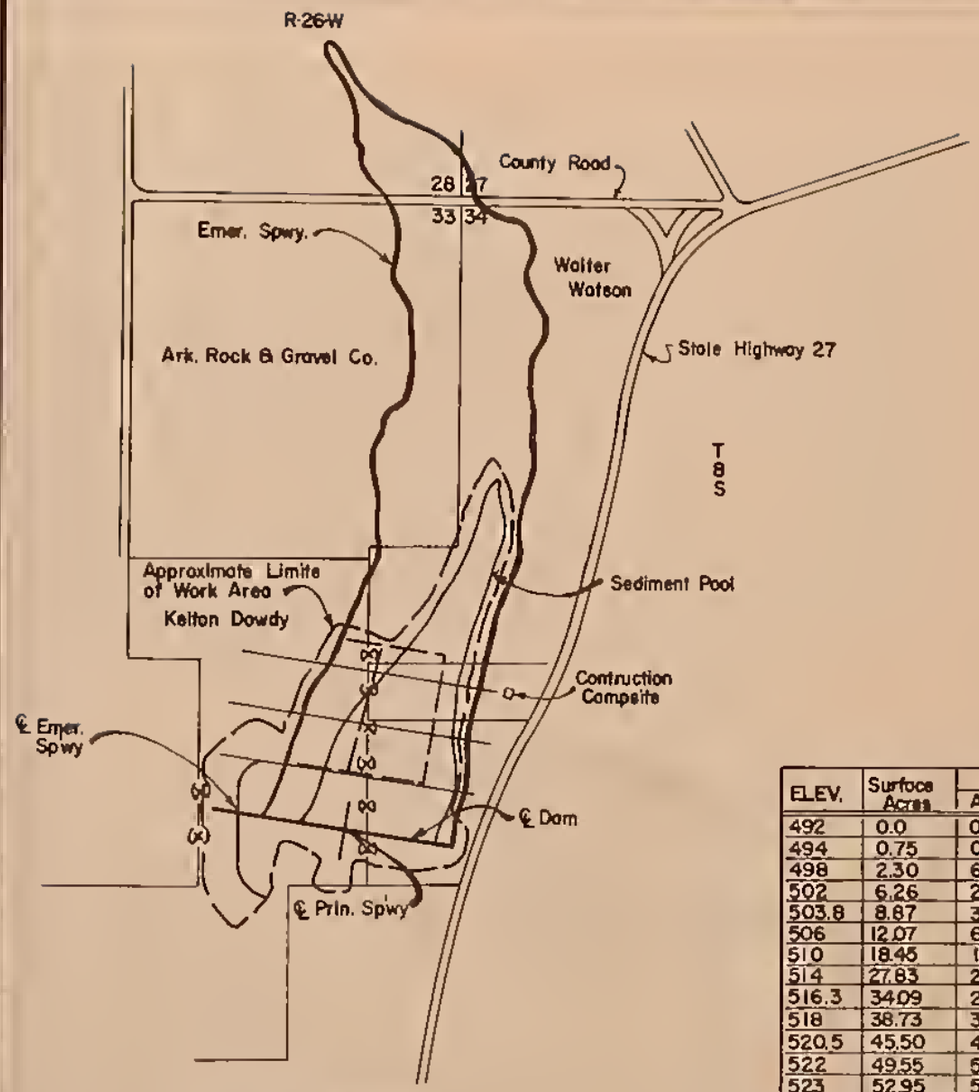


Figure 1A

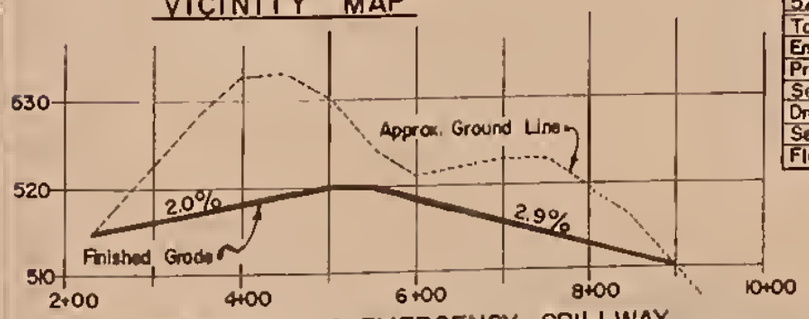
SECTION OF A TYPICAL MULTIPLE PURPOSE STRUCTURE



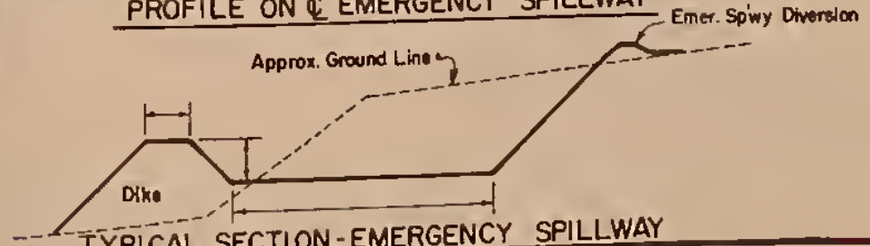
VICINITY MAP

ELEV.	Surface Acres	STORAGE AC.-FT.	STORAGE INCHES
492	0.0	0.0	0.0
494	0.75	0.75	0.01
498	2.30	6.85	0.10
502	6.26	23.97	0.33
503.8	8.87	37.40	0.52
506	12.07	60.57	0.84
510	18.45	121.61	1.69
514	27.83	214.17	2.99
516.3	34.09	285.40	3.97
518	38.73	347.34	4.83
520.5	45.50	447.80	6.22
522	49.55	523.86	7.27
523	52.95	575.11	8.00
524	56.37	629.77	8.74

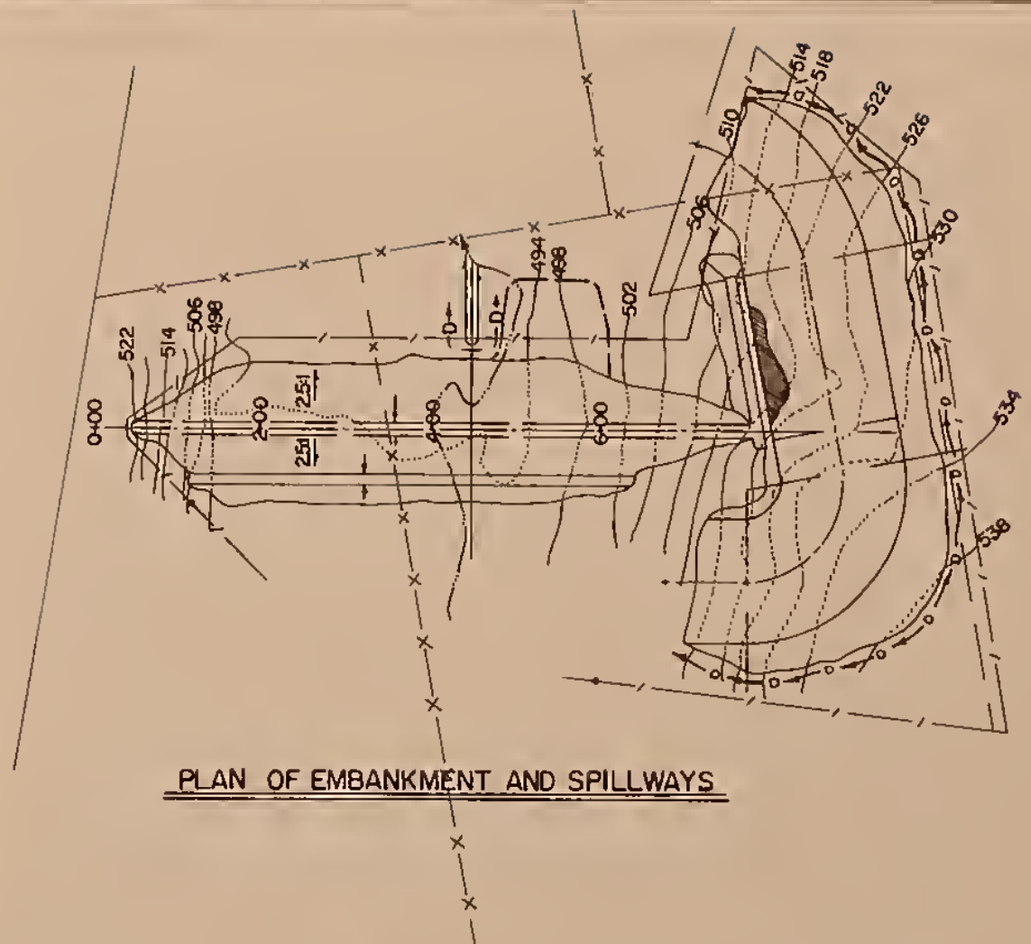
Top of Dam (effective) Elev.	523.5
Emergency Spwy Crest Elev.	520.5
Prin. Spwy Crest Elev.	516.3
Sed. Pool & Port Elev.	503.8
Drainage Area - Acres	864
Sed. Storage - Ac. Ft.	73.40
Floodwater Storage Ac. Ft.	374.4



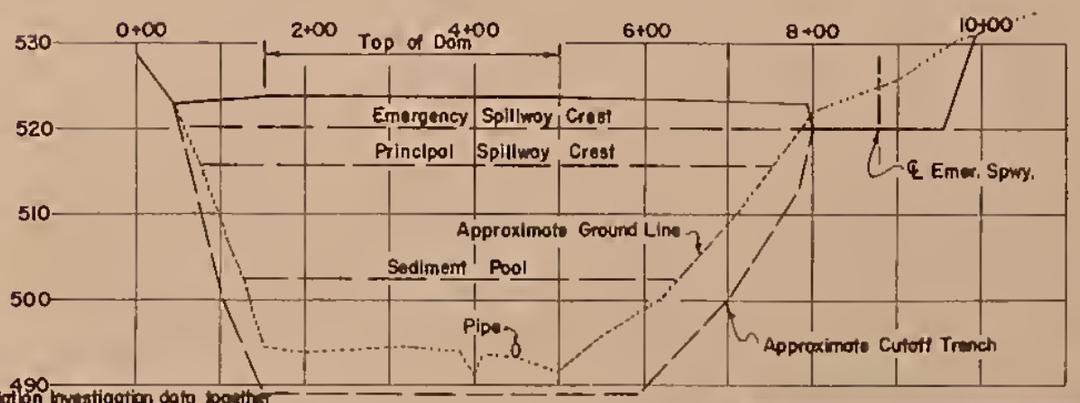
PROFILE ON ℄ EMERGENCY SPILLWAY



TYPICAL SECTION - EMERGENCY SPILLWAY



PLAN OF EMBANKMENT AND SPILLWAYS



Additional soil and foundation investigation data together with laboratory test data are available in S.C.S. field construction office for review by prospective bidders.

PROFILE ON ℄ DAM

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed ..... Date .....
Drawn .....
Traced .....
Checked .....

Approved: Kyle A. Polish
State Conservation Engr.

4-L-30711-1

4-30703

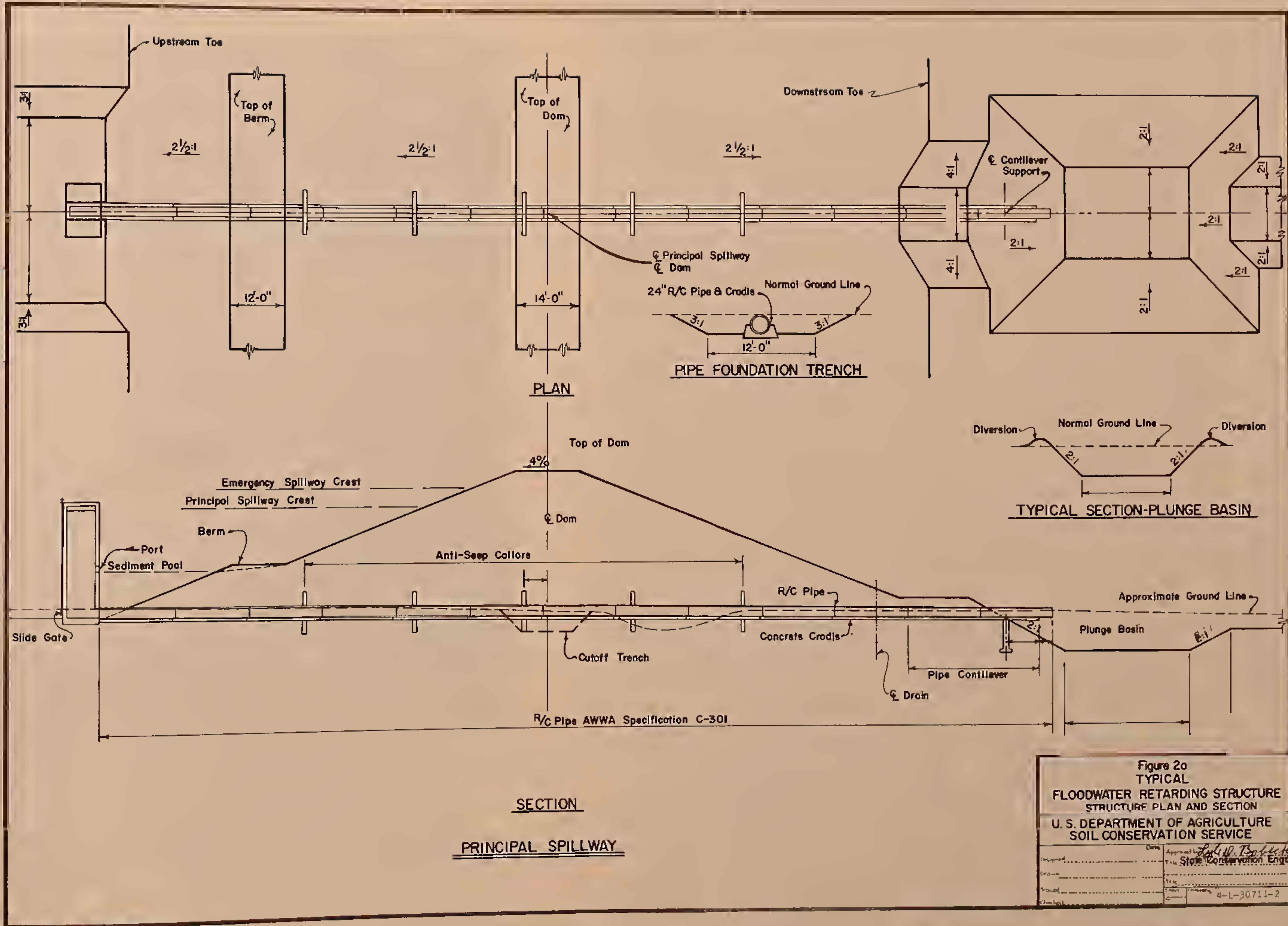


Figure 2a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

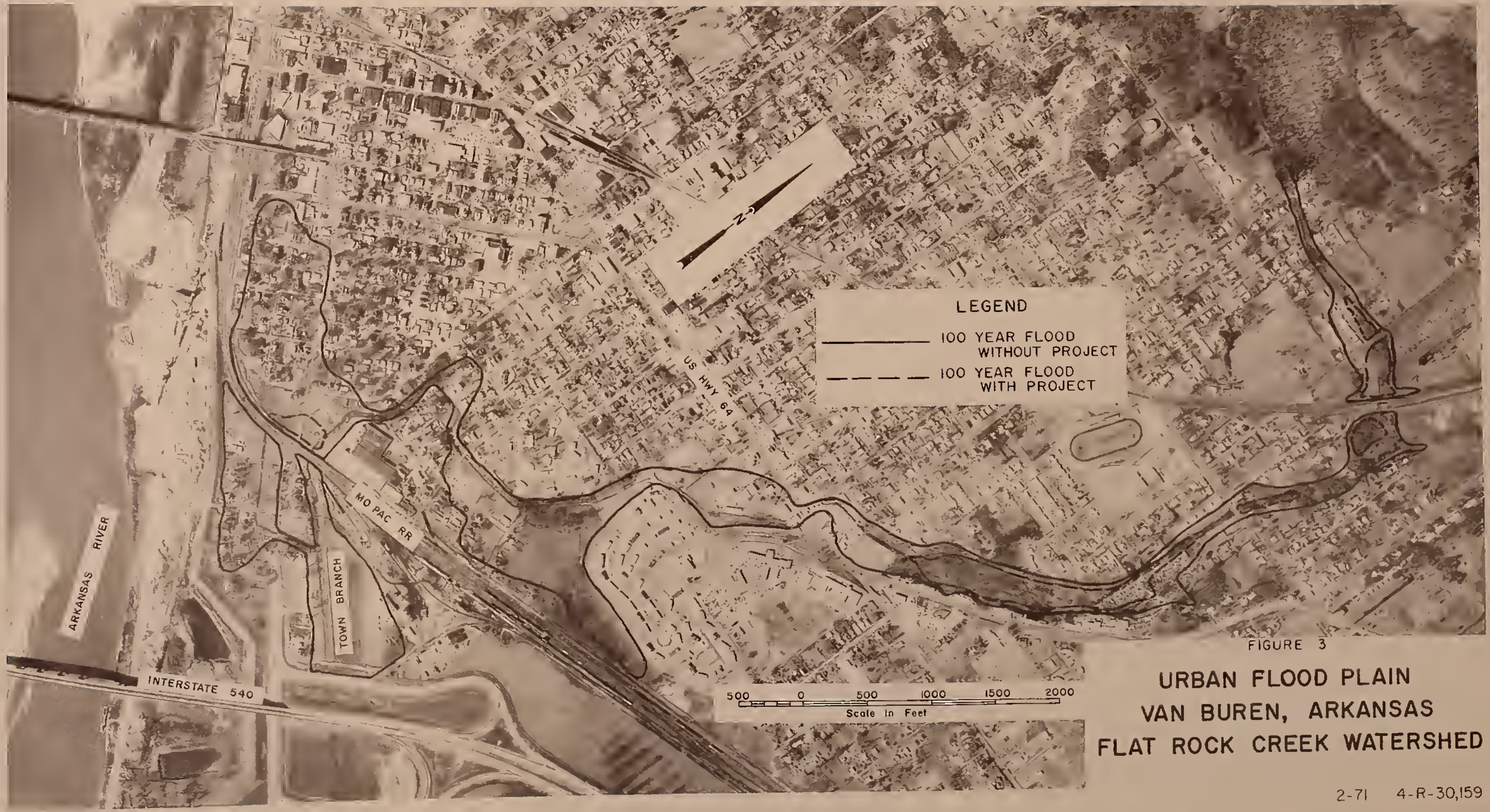


FIGURE 3

URBAN FLOOD PLAIN
VAN BUREN, ARKANSAS
FLAT ROCK CREEK WATERSHED

2-71 4-R-30,159

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE LITTLE ROCK ARKANSAS
USDA-SCS-NOAT MOSIH. FEB. 1971

SITE NUMBERS AND DRAINAGE AREA IN ACRES

Site No	Acres
1	230
2	3,309

R 32 W R 31 W

94°20'

35°30'

35°25'

T 10 N
T 9 N

T 9 N
T 8 N

Furry

SAN FRANCISCO R R

ST LOUIS &

MISSOURI PACIFIC R R

Shibley

MISSOURI

VAN BUREN

R-II BRANCH

Sta. 70+00

TOWN BRANCH

R-I

R-II

Sta. 203+16

FLAT ROCK CREEK WATERSHED

ARKANSAS

Reach

ROCK

MISSOURI PACIFIC INDUSTRIAL PARK

Sta 236+91

Sta. 373+50

BRANCH

HOLLIS LAKE

ARKANSAS RIVER

LEGEND

- Interstate Highway
- U S Highway
- State Highway
- Low Type Road
- Gravel Road
- Unimproved Road
- Railroad
- City or Town
- Drainage
- Marsh
- Lake
- Dike
- Watershed Boundary
- Area Benefited
- Drainage Area Controlled by Structure
- Floodwater Retarding Structure
- Multiple Purpose Structure (R-Recreation)
- (1) Structure Number
- Sta 203+16 Station Number
- R-I Evaluation Reach
- Channel Improvement For Flood Prevention
- Bridges to be Installed (Note: 7 Additional Bridges Within City Limits of Van Buren)
- Watershed Outlet

Figure 4

PROJECT MAP

FLAT ROCK CREEK WATERSHED

CRAWFORD COUNTY, ARKANSAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LITTLE ROCK, ARKANSAS

APPROX SCALE 1 48,000

TOTAL D A 18,952 ACRES

Base compiled from USGS quadrangle sheets and latest available General Highway Maps

POLYCONIC PROJECTION

3-71 4-R-30189
Rev 3-71 4-R-20120